POWER

Established 1884—McGraw-Hill Publishing Company, Inc.
PHILIP W. SWAIN, *Editor*

FEBRUARY, 1934 **Volume 78, Number 2**

WHAT'S AHEAD?

• WHAT WILL HAPPEN to the power field in 1934? Here are a few reasonably safe predictions: First consider general business, which power activity serves, and from which it must live. A steady upward movement during the first few months of 1934 is practically certain. Continuation of this rise throughout the year seems probable.

• UTILITY LOADS WILL GROW steadily and in some districts will approach generating capacity. Some utilities will expand capacity with new plants or additional units.

• AS MONEY COMES IN, many industrial plants will start cleaning out the power junk that has been accumulating through the combined action of obsolescence and accelerated depreciation. Step-by-step modernization, already started, will move ahead. Plant owners will begin to realize long-delayed operating savings.

• WITH PROHIBITION DEFINITELY OUT and long-term plans thus made possible, the 100-per-cent-obsolete power equipment of hundreds of breweries and distilleries will be modernized and many brand-new plants will be built to assuage the great American thirst. Lower power costs—new jobs for engineers.

• PACKING HOUSES, just waking up to the fact that they have been wasting far more than the squeal, will more and more learn how to generate by-product power from their huge flow of process steam.

• OTHER INDUSTRIES, longer aware of this No. 1 public enemy—heat waste—will perfect their already excellent hookups by increased steam pressures where the additional power recoverable can be used or sold.

• HUNDREDS OF POWER PROJECTS initiated by the funds of the Public Works Administration, and listed in recent issues of POWER, will get into full swing.

• THE DIESEL ENGINE will continue its rapid progress, but mainly in those applications where process steam is not required in large quantities.

• AUTOMATIC CONTROL, motors, and regulating devices, whose value is now thoroughly established, will find wider use in industrial and utility power plants.

• WE BELIEVE that 1934 will be a year of broadening interests and steadily increasing prosperity for those engineers who have cast their lot in the field of power.

INDUSTRIES COMPETE

A NEW PROBLEM—industry competition—has NRA guessing. It's a tough knot even for the gang of doers that has seized once-sleepy Washington.

Each industry code takes the bite out of unfair competition within that industry, but how about the buyers' money sliding somewhere else entirely? If the coal men or the oil men set up a pretty internal picture, with plenty of wages and profits and no one chiseling, higher prices may force users *en masse* to the competitive fuel. Then what to do about it?

Our guess is that this problem will be solved in part, but we wouldn't dare guess how.

DO THEY WANT THE LOAD?

A "POWER" READER writes: "It is obvious that utilities may not expect to secure power loads in industries requiring a large amount of process heat unless they are prepared to supply that heat, or are prepared to join with the industries in building stations to supply both heat and power, excess power to be absorbed by the utility." Utilities see much grief and little profit in such arrangements. They may be right, for this picture is no bed of roses. The fact remains, however, that as the depression fades many process industrials are planning to build or enlarge their own plants to supply both heat and electricity.

If there is anything in this idea of joint supply of steam and electricity, now is the time to find out. Tomorrow may be too late.

JOB FOR A DIESEL

A SMALL FACTORY in the East produces metallic powders electrolytically. The load is practically constant at 1,000 kw., 24 hr. daily, 6 days a week and practically 52 weeks a year. The product can be stored. The process can be stopped and restarted at any time without damage. It would appear that three 500-kw. diesel generating sets, or perhaps only two such sets with ample spare parts, would be adequate for this job.

Figuring the plant at $80 per kw., allowing 15 per cent for fixed charges, and assuming an 80 per cent yearly load factor, the fixed charges would amount to less than two mils per kw.-hr. This should make an ideal diesel installation.

SPECIALISTS

A MEDICAL SPECIALIST is all right if your sickness happens to be his specialty. Otherwise, beware the man who can cure only the fits.

This advice applies to steam and diesel specialists among consulting engineers. They fill the bill where the proper power solution is entirely diesel power or steam power. But it becomes more and more apparent that steam and diesel often work best in double harness. Where there is any possibility that a combination plant may pay best, serious economic errors may be made by the consulting engineer who knows "all about steam" or "all about diesels" and nothing else.

ABOLISH DEPRECIATION?

A WHILE BACK one of the *Power* editors had a long talk with Bill Stout, inventor of the all-metal airplane and pioneer in the field of high-speed, low-weight trains. Said Stout, "Depreciation is a thing of the past; things get out of date before they wear out and manufacturers should design equipment on that basis. Don't pay for life that can never be economically used, because a better machine will come along first."

Ideas like this are always emanating from Detroit and most of them are worth a lot of thought. Granting many exceptions, isn't there something in Stout's idea? Think what it cost to try to wear out some of the Corliss engines built back in the eighties.

"NO SMOKING"

THERE ARE two approaches to the smoke problem, typified respectively by the two phrases: "Please be good" and "Can't you read that sign?", the latter uttered by a policeman. Experience shows that the first won't work, but that the second may.

Just now smoke-abatement work is stagnant; Old Man Depression cleaned the skies by shutting down plants. But as production returns, smoke comes back with it. The same public that is learning to demand clean finance, clean politics, clean streets and a general clean deal, will demand clean stacks and will probably back this demand with real laws.

POWER STANDS FOR

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of By-Product Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

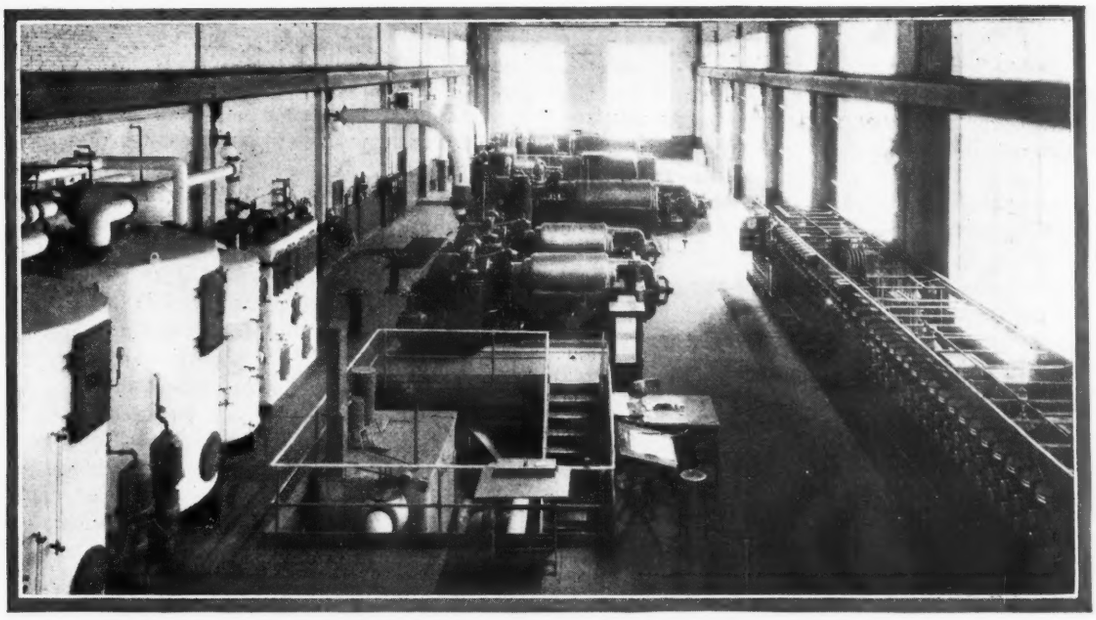


Fig. 1—Hershey's turbine room contains 20,000 kw. of generating capacity

A "SWEET" INDUSTRIAL POWER PLANT—

HERSHEY ADDS NEW BOILERS

By ALTON KIRKPATRICK
Mechanical Engineer with Albert C. Wood

Pressure raised from 200 to 400 lb.; pulverized coal improves efficiency; new dust-recovery equipment prevents fly-ash nuisance; present plant capacity, 20,000 kw.

THE main power plant of the Hershey Chocolate Corp., at Hershey, Pa., not only supplies power, process steam and heating service to the chocolate factory, but it also furnishes electricity for power, lighting and traction purposes to the Hershey Electric Co. and heating service to a number of large public buildings and schools in the town of Hershey.

When construction of this plant was begun, in 1919, provision was made for an ultimate installation of 5,000 kw. of generating capacity and for 75,000 sq.ft. of boiler-heating surface. Part of this boiler capacity was intended to serve the engine room and refrigerating plant of Hershey Chocolate Corp. The initial installation comprised two 1,250-kw. turbine-generators and 30,000 sq.ft. of boiler heating surface.

By the fall of 1930, business had increased so that nearly 20,000 kw. in generating capacity was required to carry the load and provide necessary spare capacity. A 3,500-kw. unit was first added, then, in a few years, a 6,000-kw. unit, followed by one of 7,500-kw. capacity, an extension of the turbine room being necessary to accommodate the last two units. At this time, the boiler plant contained seven 7,500-sq.ft. boilers in the main power plant, supplemented by one 10,000- and two 4,500-sq.ft. boilers in the old boiler house, all being built for 200 lb. working steam pressure, 100 deg. superheat, and equipped with overfeed, natural-draft stokers.

As additional boiler capacity was needed, a number of plans were considered to obtain the increased output and to better over-all plant efficiency by eliminating the old boiler plant. These plans were briefly as follows:

Plan A—Altering and equipping existing boilers, one at a time, for burning pulverized fuel.

Plan B—Installing in the existing boiler house three new boilers, built for 450 lb. steam pressure, each having a capacity of 150,000 lb. of steam per hr., the boilers being provided with air preheaters and furnaces suitable for pulverized fuel. The new boilers, under this plan, would have to be installed one at a time, the old boilers being removed to provide space for the new units.

Plan C—Equipping existing boilers with underfeed stokers and installation of an additional 7,500 sq.ft. boiler.

In carrying out any of the plans no interference

with plant operation or curtailment of output could be considered.

Preliminary studies were made of various arrangements under the three plans, and installation and operating cost considered. Plan B, while involving a much greater outlay, was decided upon as best from the long-range point-of-view. Plan A appeared attractive from the standpoint of low investment and possible fuel savings, but there were several undesirable and, to some extent, experimental features connected with it, and it did not permit the economies from the use of high-pressure and high-temperature steam which were a feature of Plan B. Plan C had little except low first cost to recommend it, it being impossible, under the conditions, to make a satisfactory underfeed stoker installation.

On account of the high annual load factor, which, in normal times, is in the neighborhood of 62 per cent (based on the maximum half-hour peak), it was at first thought desirable to provide heat recovery equipment to the fullest extent possible, and economizers as well as air heaters were indicated. Further consideration, however, showed that the feed water could be heated to over 300 deg. by steam extracted from the impulse chamber of the 6,000-kw. and 7,500-kw. turbines as shown on the heat-flow diagram, Fig. 3. The space required for the economizers was not available, and the added investment and complication were not justifiable. A water-wall furnace was decided upon, to obtain greater steaming capacity in the limited space available, and to avoid furnace brickwork maintenance with consequent boiler outage.

A preliminary layout of four units for the ultimate plant showed it possible to install steam generators each having a maximum capacity of 150,000 lb. of steam per hr., and that these could best be arranged parallel to and on either side of the overhead coal bunker, with the burners and firing fronts facing toward the center of the boiler house (Fig. 2). This arrangement was particularly suited to centralized control operation. Three Edge Moor, bent-tube four-drum boilers of the above capacity were installed to generate steam at 450 lb. pressure and 650 deg.

The existing radial brick chimneys ($10\frac{1}{2}$ ft. in diameter and 250 ft. high) were utilized for the new boilers, but new openings above the roof line had to be made in the chimneys to accommodate the new steel flues.

The boiler furnaces, designed for pulverized coal firing, are 18 ft. $10\frac{1}{2}$ in. wide by 20 ft. 4 in. long. Rear and side walls are water-cooled with $3\frac{1}{4}$-in. tubes spaced on 6-in. centers in the side walls and on $6\frac{3}{4}$-in. centers in the rear walls, are backed up with refractory tile bolted to the tubes, 4 in. of insulation and $\frac{3}{16}$-in. steel plate casing. The lower side walls converge to form a hopper bottom, which is faced with cast-iron blocks. Front, or burner wall, is provided with ten $3\frac{1}{4}$-in. bare tubes, widely spaced to insure stability to the solid firebrick wall at the front of the furnace. Furnace volume is 8,300 cu.ft., and the maximum rate of heat liberation, based on this volume, is 24,000 B.t.u. per cu.ft. per hr. Air heaters are of the tubular type, having two gas and two air passes. A summary of the different types of heating surface in each steam generating unit shows: Boiler, 11,200 sq.ft.; Superheater, 2,200 sq.ft.; Water walls, 1,448 sq.ft.; Air preheater, 19,300 sq.ft.; Total, 34,248 sq.ft.

Pulverizers are unit Foster Wheeler ball mills, each having a capacity of 7,000 to 8,000 lb. of coal per hr., two units per boiler being provided. A primary air fan is connected to each pulverizer, and supplies two "Toronto" coal burners per boiler, arranged for firing under the lower drum of the boiler. Burner piping is not inter-connected.

Ash and dust emanating from the boiler plant could not be tolerated, and some form of dust separators would have been installed whatever type of firing were

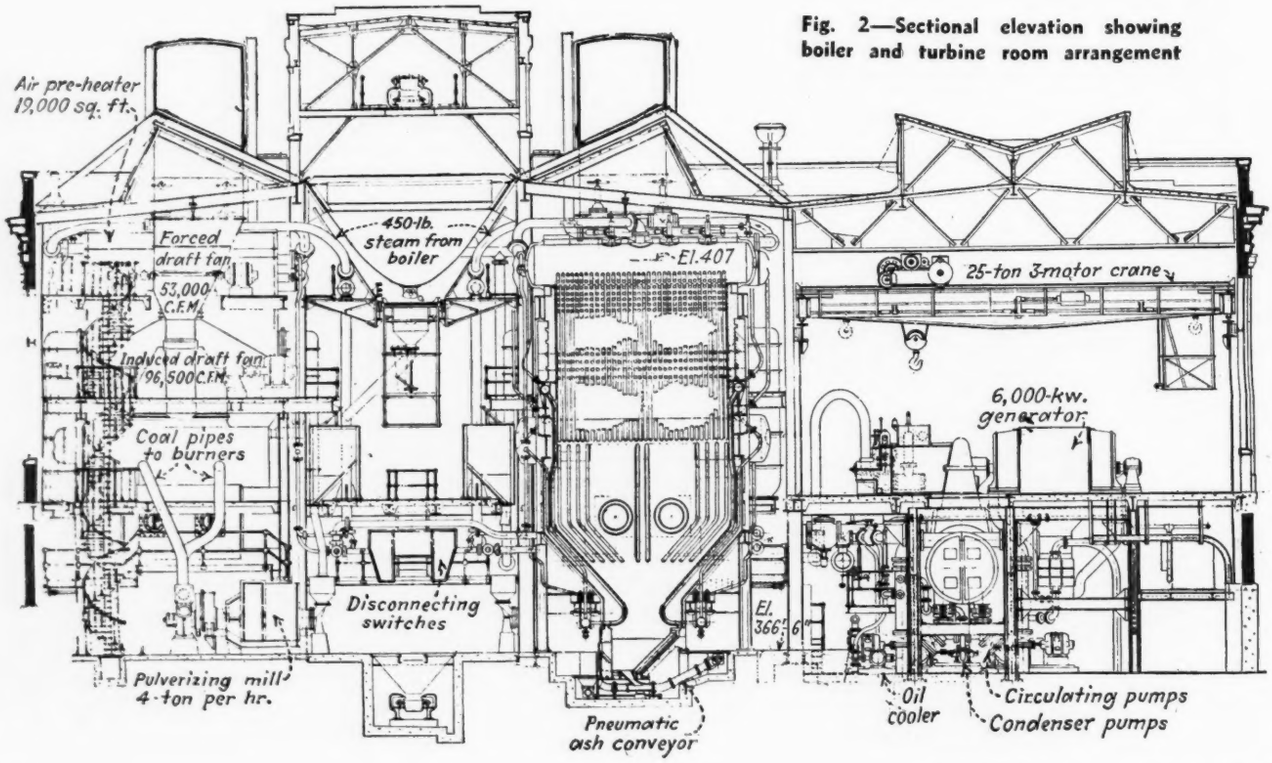


Fig. 2—Sectional elevation showing boiler and turbine room arrangement

decided upon. The system installed by the American Blower Corp. is illustrated in Fig. 4. Primary separators, consisting of 65 cast-iron nested tubes, are installed in a section of the main gas flue, ahead of the induced-draft fans. These cast-iron tubes have a helical vane cast integrally inside each tube, its purpose being to create centrifugal action which throws the dust particles outwardly to the tube wall. At the ends of the tubes, the heavily dust-laden gas is skimmed off and bypassed through an annular channel to a separate dust chamber, while the core of cleaner gas continues on to the fan and stack. The gas and dust bypassed to the dust chamber is drawn by a small fan through an auxiliarly cyclone collector, where the final dust precipitation takes place. From this collector, the dust falls by gravity into a tank and is withdrawn at intervals and discharged into a large ash-storage bin at the west end of the boiler house.

No accurate data on the dust-separating efficiency of this type of collector are available. With coal containing 8.6 per cent ash, burned at the rate of 9,600 lb. per hr. per boiler, an approximation, based on the content of the collector tank, indicates that the dust collectors account for approximately 50 per cent of the ash in the coal, while 25 per cent, consisting principally of superfines, passes to the induced-draft fan on the way to the stack.

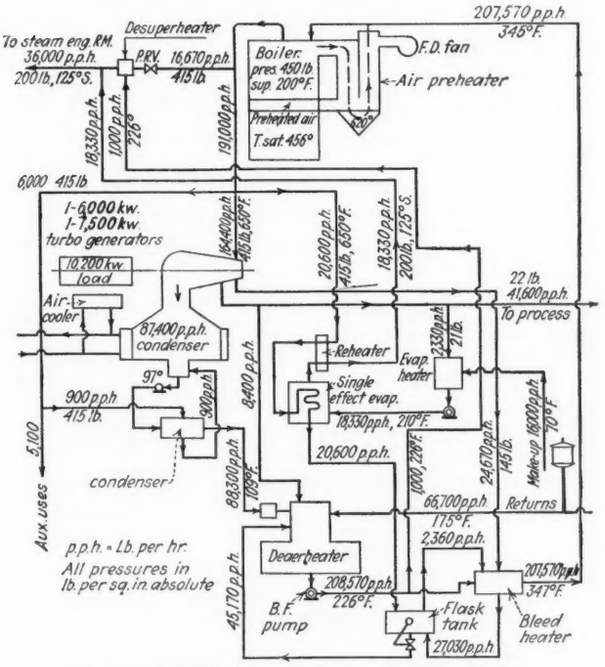


Fig. 3—Heat balance diagram with new boilers

The draft loss through the primary collector, when operating at a rate of 120,000 lb. steam per hr., is of the order of 0.7 in. with 15 per cent CO_2.

Ash- and Dust-Handling and Disposal System

The ash- and dust-handling and disposal system is unique in that the ash is withdrawn directly from the boiler ash pits by a vacuum conveyor system and stored dry in a large concrete ash bunker, watered, and discharged by a rotary dustless unloader to motor trucks.

Ash pits are each provided with three water-cooled ash inlets of special design, into which the ash is fed by poking through small doors in the side of the boiler ash hopper. Any large clinkers or pieces of slag can be withdrawn through doors in the ash-hopper front. An auxiliary conveyor line with the conventional intakes in front of and outside the boiler ash hopper is provided in case of a stoppage in the direct-withdrawal system.

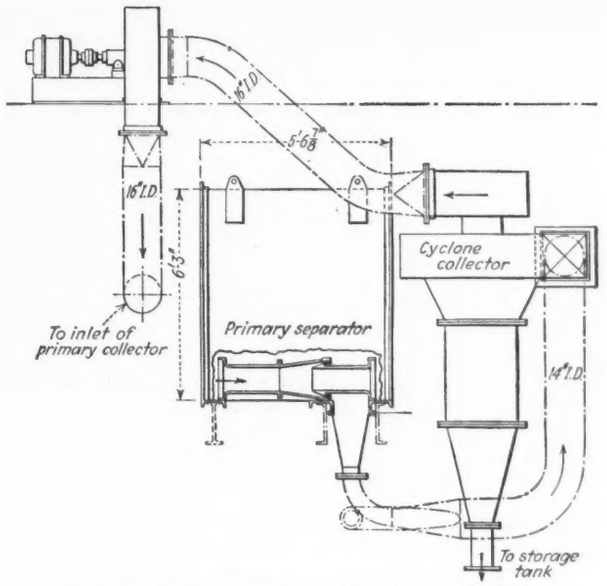


Fig. 4—Dust-recovery equipment installed in boiler flue ahead of induced-draft fan

At a central point on the operating floor, there are located the gage boards and control panels, steam and electrical, for controlling the operation of the boilers, pulverizers and forced- and induced-draft fans. On the boiler-gage panels are mounted draft gages for both the forced- and induced-draft systems, CO_2 recorder, steam flow meter, and steam temperature recorder, besides electric pyrometer equipment for reading essential gas and preheater air temperatures. Beside each instrument panel an electrical remote control panel is installed, with electrical metering equipment, pushbutton control for all auxiliary motors and automatic draft control.

The pulverizers on the basement floor are controlled as to rate of coal feed and preheated primary air to the mills and burners through a system of rods, levers and worms, terminating at the control boards in handwheels with position indicators. The control-board operator, from his central position, also observes the boiler water gages, which are of the inclined type facing toward the center of the boiler-house aisle.

Feed water is supplied to the new boilers by three centrifugal boiler feed pumps, two having a capacity of 365 g.p.m. and direct connected to 200-hp., 1,800-r.p.m., synchronous motors, and one being steam-turbine driven, with capacity of 550 g.p.m.

The feed pumps obtain their supply from two deaërating heaters and discharge through an extraction heater into a duplicate and interconnected feed-line system. One of the old, open-type, feed-water heaters in the turbine room is utilized for receiving the condensate from the factory heating system and milk condensing department, from which it is discharged by an auxiliary pump through oil filters to the deaërating heater.

Feed-water makeup is supplied by two single-effect

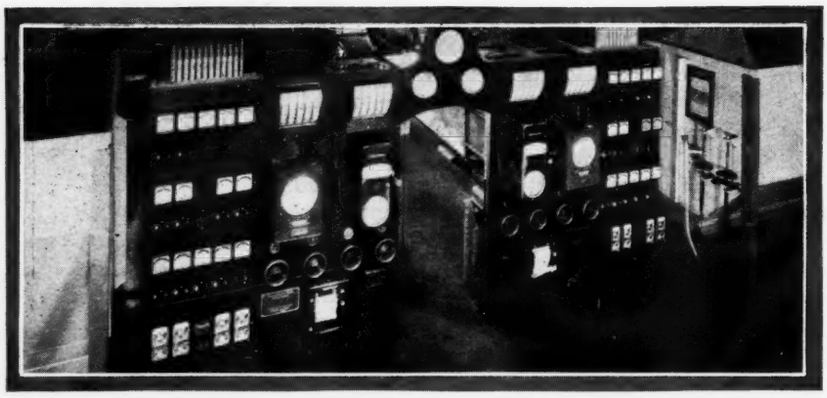


Fig. 5—Control of boiler-room auxiliaries is centralized

▼

evaporators, each having a capacity of 12,000 lb. of makeup per hr. Steam supplied to the evaporators at 400 lb. pressure and 650 deg. F. first passes through a reheater, where it imparts 140 deg. F. superheat to the 190-lb. steam vapor from the evaporators. This 190-lb. superheated steam from the evaporators is used in the factory, and part of the condensate is returned to the power plant. Makeup water to the evaporators is a very soft water normally containing about 3 gr. of hardness per gal.

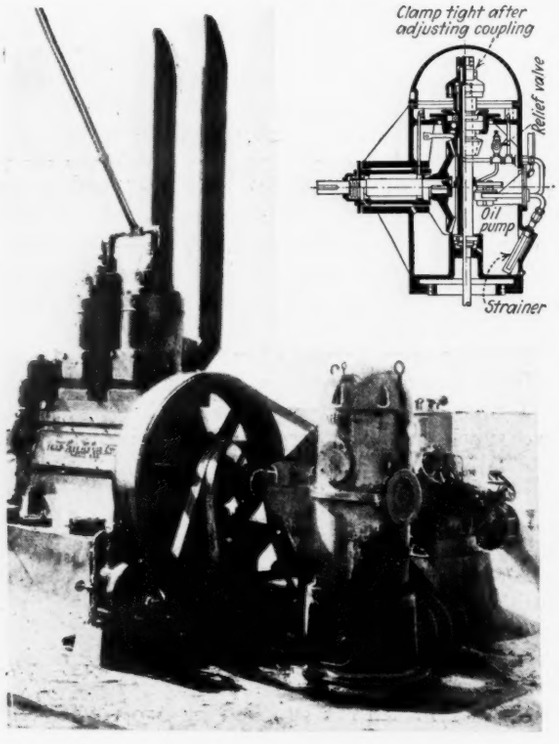
Pressure-Reducing Valves and Desuperheater

When the original power plant was constructed in 1920, boilers were installed for 200-lb. maximum pressure and 125 deg. F. superheat. Normal operating pressure was about 180 lb. With the increase in pressure and temperature to 400 lb. and 650 deg. F., it was found desirable to provide 180-lb. steam for the turbines that could not be converted to use the higher pressure and for refrigerating machines and certain factory equipment that were also not suited to the new steam conditions. This necessitated the installation of pressure-reducing valves and a desuperheater. This equipment was also required for several months during the change-over from 180 lb. to 425 lb. pressure, when, on account of circulation in the water walls, it was not advisable to operate the new boiler units at less than 400 lb. pressure.

Two reducing valves were installed: One 4 in. and one 6 in., controlled by hydraulic regulators. The desuperheater is of the jet type with temperature control. Water for desuperheating is obtained from the boiler feed-line header ahead of the extraction heater.

A. Bowman Snavely, chief engineer, and W. C. Hackman, operating engineer, of the Hershey Chocolate Corp., assisted in coordinating the new work, and collaborated with Albert C. Wood, consulting engineer of Philadelphia, in the design, selection and arrangement of the equipment.

HIGH-SPEED RIGHT-ANGLE GEAR UNIT JOINS ENGINE AND PUMP



● IN THE CENTER of the Mojave Desert, at Hinkley, hottest spot in California, State Development Co. has installed a Venn-Severin diesel driving a deep-well pump. They are connected with a 100-hp. Farrell-Birmingham right-angle drive of the type shown in the diagram. Despite sand and sun, the installation has been operating day in and day out without trouble.

This is particularly interesting when it is considered that this is heavy-duty work of the type which drives of a few years ago could not handle. Either units were too light and too small, or so heavy that they were mechanically inefficient.

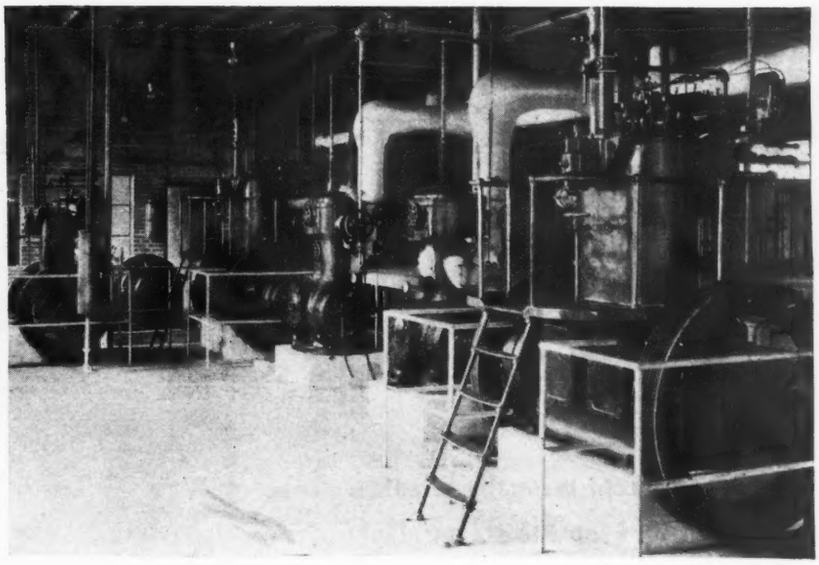
Better materials and workmanship have overcome the difficulty. Spiral bevel gears of heat-treated alloy steel give the necessary silence, strength and long wear. Lubrication is provided by a special pressure pump, and ball bearings take the thrust.

A special coupling which can be clamped in position allows necessary flexibility in set-up.

Several other installations of a similar type have been made. One is between a Worthington gas engine and pump, also on the Pacific Coast, and two others are in the plant of the Jamaica Water Supply Co., Jamaica, N. Y., where two 125-hp. Fairbanks-Morse diesels drive deep-well pumps.

A 65-hp., 327-r.p.m. gas engine and a 40-hp., 400-r.p.m. unit on either side of an alternator provide two power ranges through V-belt drives. The larger engine also drives an ammonia compressor by flexible coupling at 900 r.p.m. Another 65-hp. engine drives an alternator similarly and has a V-belt sheave for auxiliary power

Independence Ice & Refrigerating Co., Tulsa, Okla.



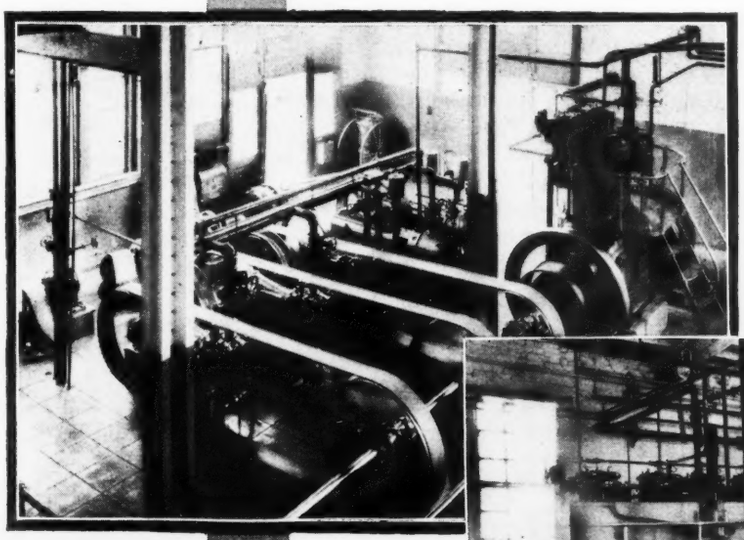
Photographs courtesy Bruce-Macbeth Engine Co.

BELTED REFRIGERATION

Belts permit quick shifts and different speeds from single-speed prime movers

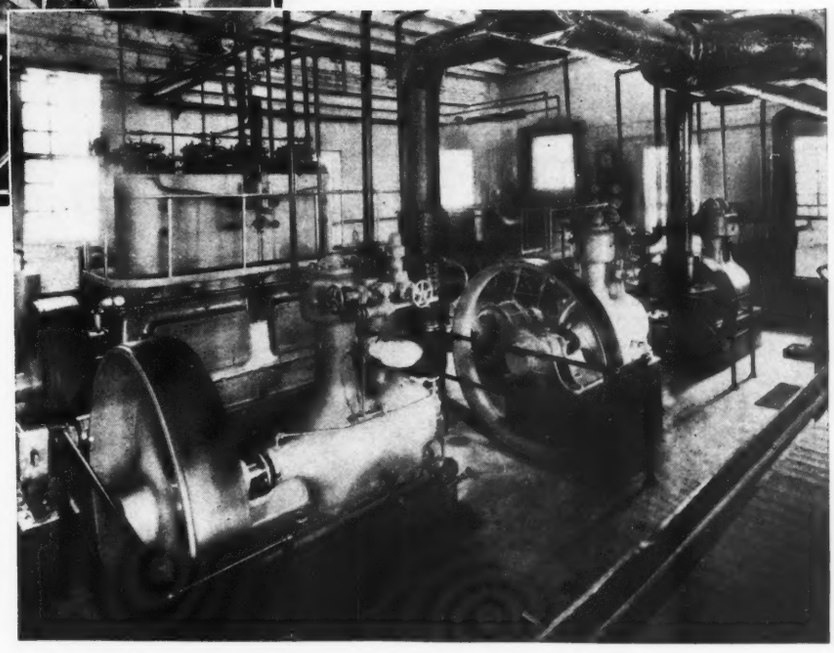
Left—This 80-hp. gas engine drives an alternator from one end of its shaft and a line shaft from the other. Flat belts from the line shaft drive two compressors; a third is driven by a motor powered by the alternator. Motor drives for belt-driven units are also provided.

Southern Ice & Utilities Co., Dallas, Tex.



Below—A 165-hp., 277-r.p.m. gas engine drives an ammonia compressor by flat belt from each end of its shaft, the first at 210 r.p.m., the other at 150. A 1,200-r.p.m. alternator is driven by V-belt. Another 65-hp., 327-r.p.m. engine drives a 150-r.p.m. compressor by flat belt and a 900-r.p.m. alternator by V-belts

Heights Ice Co., Houston, Tex.



WEIGH COAL AT THE GATE—

DON'T PAY FOR FUEL YOU DON'T GET!

Records kept manually or automatically keep the steam plant operator from buying a "pig in a poke"

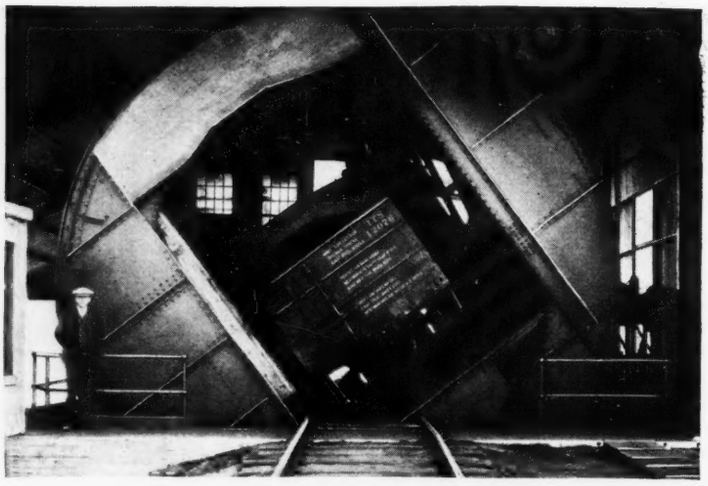


Fig. 1—Rotary car dumper on scale weighs and unloads coal automatically

FUEL is a major expense item in steam-plant operation, but has not, in general, been given the attention that its importance warrants. In many plants, extreme care is taken to obtain quality and full weight of fuel, and to maintain high combustion-process efficiency, but there are a large number in which no attention is given to these important details. One of the best arguments against the latter practice is that the cost of services rendered by a steam plant is in almost inverse proportion to the intelligence put into operation.

Intelligent operation of a steam plant begins with fuel, and the starting point is knowledge of the quality and quantity received. Where coal is the fuel, it should be weighed when delivered to the plant. Many weighing methods are available; selection of the most suitable one will depend upon how fuel is received, size of plant, capital available for purchase of equipment, local conditions, and other considerations. Whatever these may be, both manual and automatic weighing equipment is available to meet the requirements.

Weighing coal as received insures receipt of the weight paid for. Fig. 2 shows a scale installed at a department store for weighing coal as received by truck. This is typical of a truck-served small-size plant. The weight of each truck with its load is indicated and recorded automatically. After the load is dumped, the truck is weighed again alone and its weight recorded. This eliminates the possibility of underweight due to error, coal sticking in the truck, or for other reasons. Experience in operating the plant with and without this scale has shown it to be a desirable piece of plant equipment from economic as well as other standpoints.

Where coal is received by car in large quantities, track scales are frequently installed for weighing as received. Weighing can be done either manually or automatically, the latter being preferred because it eliminates error.

The system of weighing car loads in motion that has worked so satisfactorily for automatic weight recording for large railroad freight or classifying yards, has been adapted to railway track scales for large power plants. This eliminates stopping and starting cars on the scale, thus reducing wear and tear on them. No weights are lost from cars passing over the scales; the weight recorder automatically insures against this. Coal may be immediately checked against invoice weight. An absolute check weight of the coal is provided, and the automatically printed records eliminate weight controversies.

At one plant, after cars are weighed in motion they pass through the rotary dumper, are unloaded, then are again weighed to obtain the net weight delivered.

Within the last 10 years, automatic car dumpers have come into quite general use at large plants where coal is received by car. In some cases, the car dumper is mounted on a scale so that the loaded car can be weighed and then dumped, after which the empty car is weighed and each weight recorded automatically, Fig. 1.

These heavy scales have been developed until they are accurate to within about 20 lb., a negligible error. Automatic weighing and recording devices are available that can be attached to any manual scale.

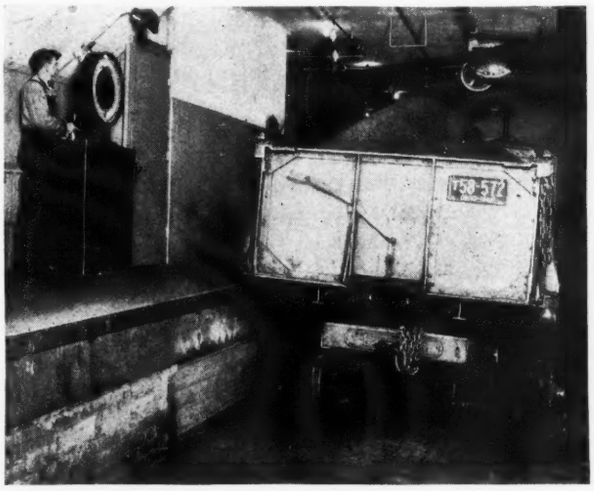
In some installations, a receiving hopper on a scale weighs the coal, then dumps it onto a conveyor or other means of delivery to bunker or storage pile. At one plant coal is delivered to a weigh hopper by conveyor. When a predetermined weight is delivered, the conveyor line is stopped, the coal weighed and its weight printed, all automatically. Then discharge gates on the weigh hopper open, the load is discharged, the gates close, and the weight of the empty hopper is automatically printed. If the hopper is empty, the recorder prints zero. Any weight more than zero shows the amount of coal remaining in the hopper and is deducted from the gross delivered. Over a period, check weights show a variation of as little as 0.05 of one per cent.

In other installations, an automatic-weighing type feeder-belt conveyor is installed between the receiving hopper, into which cars are dumped, and the conveyor going to the bunker. The equipment is entirely automatic, starting when there is coal in the hopper and stopping when the coal reaches a predetermined level.

Automatic weightometers, Fig. 4, are quite frequently installed on the belt conveyor going to the coal bunker. This device is equipped with means for continuously integrating and registering the weight of coal being carried on the conveyor. Auxiliary counters or chart recorders are available for installation at points remote from the scale. These keep a permanent record of weight of coal being handled. This equipment is guaranteed to weigh with an accuracy of more than 99 per cent any material carried on the conveyor.

Weighing Coal from Barge

When coal is received by barge, several ways are available for weighing it. It may be unloaded into a hopper and weighed on an automatic-weighing feeder conveyor or a weightometer in the main belt conveyor as previously described. Another method is to dump the coal into cars that are weighed while passing over a scale, where the net weight of coal is recorded.



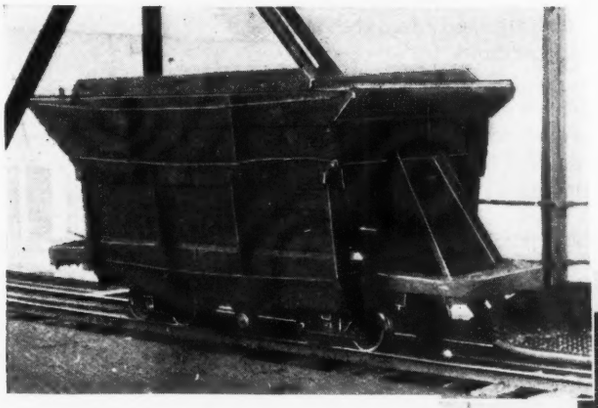


Fig. 2 (Top)—Scales installed at department-store power plant to weigh coal as received by truck

Fig. 3 (Above)—Coal cars propelled by endless cable are weighed automatically as they move over a scale

Fig. 4 (Right)—Weightometer installed on two belt conveyors to weigh coal in motion

At one plant, for example, all coal is delivered by barge. It is lifted by clamshell bucket into temporary storage bunkers, then charged into larry cars of the type shown in Fig. 3. These cars are pulled by an endless cable across a line section of a scale, and the net weight of the coal is automatically printed on a tape. The larry cars do not stop in their travel across the scales. The cars are then routed to various boiler bunkers, records being kept to show the amount of coal supplied to each boiler.

In one power-plant installation, automatic recorders are used to record weight of coal delivered to the stoker bunkers. Coal is delivered by bucket conveyor to a hand-controlled car traveling between the boilers and an overhead rail system. This car contains two complete sets of hoppers, scale levers, and automatic weight recorders. The weights are recorded on tapes which are periodically removed for accounting purposes.

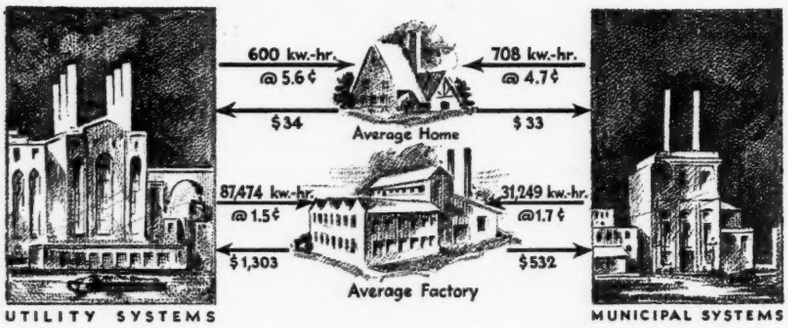
Electrically propelled weigh cars are also used to deliver coal to the bunker. The hopper on these cars is supported on a scale that will automatically record the weight of the load. These cars can be had operable by remote control or they may be fully automatic. The latter load, travel, record weights, stop, discharge, and return, all under automatic control. They can repeat this cycle indefinitely until stopped, or will stop after each trip, depending on the setting of the controller.

Weighing the coal to each boiler as it is fired will be the subject of a second article.

Acknowledgement for assistance in the preparation of this article is made to Toledo Scale Co., Fairbanks Co., Fairbanks Morse & Co., Streeter-Amet Co., Howe Scale Co., Buffalo Scale Co., Wellman Engineering Co., Atlas Car & Mfg. Co., Merrick Scale Mfg. Co., Schaffer Poidometer Co., Richardson Scale Co.

CORRECTION—The article "What Power Plants Can Do About Smoke Abatement," by A. E. Gruenert on pages 542 and 543 of *Power* for October, 1933, was credited as an abstract of an A.S.M.E. paper. It was, instead, a paper before the 27th Annual Convention of the Smoke Prevention Association at the Hotel LaSalle, Chicago.

Two photographs of the new municipal plant at Piqua, Ohio, shown in the January number on pages 3 and 13, were loaned by Elliott Co.



WHAT ELECTRICITY COSTS

HOW MUCH does electricity cost—that is, what does it sell for? (This article deals only with purchased electricity; "cost" is used throughout to mean the *billed price.*) The answer to this question, as everybody knows, is: "It all depends on the place, the customer and the load."

Well then, to be more specific, what is the average price paid for all the electricity sold to ultimate consumers in the United States? Answer: 2.8 cents.

What is the average price paid by wholesale purchasers (mainly industrials, buildings, and institutions)? Answer: 1.5 cents.

How much does the average domestic user buy in a year, and what is his bill? Answer: He buys 611 kw.-hr. and pays $34.

What are the corresponding figures for the wholesale buyers? Answer: 85,345 kw.hr. and $1,274.

Is the average rate paid for electricity by the domestic consumer higher for private utilities or for municipal plants? Answer: The typical domestic user pays a lower rate (4.7 cents as against 5.6 cents) for municipal plant power, but he uses enough more current to make his yearly bill about the same—$34 for utility power and $33 for municipal power.

How about wholesale buyers? Answer: The average wholesale buyer pays a higher rate for municipal power—1.7 cents as against 1.5 cents for utility power. And right here is one of the pitfalls of statistics, for the average wholesale customer takes 87,474 kw.-hr. per year if he buys from a utility, but only 31,249 kw.-hr. if he buys from a municipal system.

Well then, how much allowance should be made for the effect of this lower consumption on the average rate? Answer: Who knows?

All of these statistics have been extracted from a single sheet of paper just issued by the U. S. Government, specifically, the 1932 Census of Electrical Industries, Department of Commerce, Bureau of the Census, Washington, D. C.

The table at the bottom of these two pages presents the Department of Commerce tabulation in detail, as far as the whole U. S. is concerned. Table II presents, in addition, those items from the geographical breakdown that should be of greatest interest to *Power* readers as industrial consumers. The original report gives the regional data in practically the same detail as that for the country as a whole.

Customers tabulated are ultimate consumers only. This census takes no account of electricity transferred from one utility to another or between utility and municipal systems for resale.

The customers discussed in the questions and answers above are those tabulated by the census respectively as "domestic service" and "large light and power, wholesale." The latter group is represented, in the chart at the top of the page, as a factory, but obviously also

TABLE I—WHAT ELECTRICITY

Class of Service	Number of customers			Current Sold: Kilowatt-hours			Average kw.-hrs. per customer		
	Total	Commercial	Municipal	Total	Commercial	Municipal	Total	Commercial	Municipal
United States, sales to ultimate consumers, total	23,858,411	21,630,662	2,227,749	65,895,975,835	62,147,695,152	3,748,280,683	2,762	2,873	1,638
Farm service	613,753	592,692	21,061	1,504,257,106	1,488,105,684	16,151,422	2,451	2,511	767
Domestic service	19,285,560	17,337,876	1,947,684	11,790,139,511	10,410,749,374	1,379,390,137	611	600	708
Commercial service:									
Small light and power (retail)	3,527,794	3,284,326	243,468	12,059,463,977	10,793,767,814	1,265,696,163	3,418	3,286	5,199
Large light and power (wholesale)	379,402	365,038	14,364	32,380,076,220	31,931,212,851	448,863,369	85,345	87,474	31,249
Municipal street lighting	29,832	28,997	835	2,235,668,364	1,746,288,517	489,379,847	74,942	60,223	586,084
Railroad (motive power):									
Street and interurban	474	454	20	4,392,943,247	4,348,207,607	44,735,640	9,267,813	9,577,550	2,236,782
Electrified steam divisions	367	363	4	762,204,863	762,115,347	89,516	2,076,852	2,099,491	22,379
Other service	21,229	20,916	313	771,222,547	667,247,958	103,974,589	36,329	31,901	332,187

includes large buildings and institutions—in fact, any power consumer above the small retail commercial user, except street lighting systems, railways and certain miscellaneous users.

In attempting to interpret these statistics, it pays to be wary. Remember the old story about the man who sank out of sight in a river whose average depth was 9 in. He struck a deep spot. It is a common experience for bathers to wade in an ocean whose average depth is several miles. They stick to the beach. All of which shows that averages must be used with caution. They do not tell the whole story.

The mere fact that some particular consumer is paying more or less than the national average for his class does not prove that he is being robbed or favored. One must know the details of the particular situation to reach this conclusion. Nevertheless, the figures given in this census are extremely interesting.

Having studied the national picture in Table I, readers will be interested to see how the average cost to the wholesale consumer varies from district to district. This is given in Table II for the principal geographical divisions of the United States.

From Table II the reader may gather the impression that the municipal systems are consistently charging more than the utility systems in all districts. This impression is heightened by the omission of the census figures for domestic consumers. In general, the difference between domestic and wholesale rates is much greater for utility systems than for municipal systems. In every district except the South Atlantic, the municipal systems charge domestic consumers a smaller average rate than do the utility systems. On the other hand, it is generally true that the wholesale consumers pay higher average rates for municipal power than for utility power. Since, moreover, the larger part of utility power goes to wholesale consumers, their low rates pull down the average for all types of consumers below that for the municipal stations. Finally it must be pointed out again that the utility and municipal systems are not comparable in average load per customer or in certain other respects.

TABLE II—WHAT ELECTRICITY COSTS—BY DISTRICTS

Geographic Division	Class of Customers	Number of Customers			Total Kw.-Hr. Sold, Millions	Average Kw.-Hr. per Customer			Average Dollars per Customer			Average Rate c. per Kw.-Hr.		
		Total	Utility	Municipal		Total	Utility	Municipal	Total	Utility	Municipal	Total	Utility	Municipal
New England	All	2,225,513	2,064,478	161,035	4,488	2,017	2,078	1,226	70	71	48	3.5	3.4	3.9
	Wholesale	43,371	41,002	2,369	2,340	53,593	56,084	17,261	947	979	383	1.8	1.7	2.2
Middle Atlantic	All	6,674,973	6,534,395	140,590	18,127	2,716	2,748	1,200	81	82	50	3.0	3.0	4.1
	Wholesale	126,948	125,702	1,246	10,281	80,985	81,538	25,286	1,311	1,319	543	1.6	1.6	2.1
East-North Central	All	5,650,468	5,143,617	506,851	14,894	2,636	2,694	2,044	73	75	56	2.8	2.8	2.8
	Wholesale	53,496	51,684	1,812	6,754	126,256	127,815	81,778	2,004	2,029	1,285	1.6	1.6	1.6
West-North Central	All	2,326,873	1,921,587	405,286	4,754	2,043	2,233	1,141	67	71	48	3.3	3.2	4.2
	Wholesale	40,865	39,030	1,835	1,829	44,761	44,829	43,317	679	682	617	1.5	1.5	1.4
South Atlantic	All	1,778,544	1,544,631	233,913	6,750	3,795	4,168	1,337	91	95	58	2.4	2.3	4.4
	Wholesale	15,275	13,845	1,430	4,111	269,152	294,882	20,043	3,376	3,677	456	1.3	1.2	2.3
East-South Central	All	773,372	711,342	62,030	2,891	3,738	3,970	1,067	84	87	51	2.3	2.2	4.8
	Wholesale	11,309	11,206	103	1,893	167,379	168,706	23,072	1,823	1,834	696	1.1	1.1	3.0
West-South Central	All	1,234,587	1,105,165	129,422	3,464	2,806	2,998	1,163	82	86	53	2.9	2.9	4.6
	Wholesale	28,480	27,626	834	1,839	64,577	65,998	18,631	1,008	1,027	412	1.6	1.6	2.2
Mountain	All	633,851	574,647	59,204	1,958	3,090	3,276	1,278	83	86	51	2.7	2.6	4.0
	Wholesale	14,063	13,847	216	1,068	75,931	76,347	49,282	1,002	1,002	1,050	1.3	1.3	2.1
Pacific	All	2,560,230	2,030,812	529,418	8,570	3,347	3,590	2,415	69	73	54	2.1	2.0	2.2
	Wholesale	45,595	41,096	4,499	2,264	49,657	52,874	20,273	569	599	290	1.1	1.1	1.4

COSTS—UNITED STATES TOTALS

Revenue from Electric Service

Amount			Average per customer (dollars)			Average per kw.-hr. (cents)		
Total	Commercial	Municipal	Total	Commercial	Municipal	Total	Commercial	Municipal
$1,821,105,524	$1,703,303,728	$117,801,796	76	79	53	2.8	2.7	3.1
42,773,826	41,874,996	898,830	70	71	43	2.8	2.8	5.6
649,764,750	584,995,286	64,769,464	34	34	33	5.5	5.6	4.7
491,852,492	459,440,913	32,411,579	139	140	133	4.1	4.3	2.6
483,390,649	475,738,880	7,651,769	1,274	1,303	532	1.5	1.5	1.7
92,010,645	81,795,213	10,215,432	3,084	2,821	12,234	4.1	4.7	2.1
38,777,175	38,296,902	480,273	81,808	84,354	24,014	0.9	0.9	1.1
7,018,519	7,015,342	3,177	19,124	19,326	794	0.9	0.9	3.5
15,517,468	14,146,196	1,371,272	731	676	4,381	2.0	2.1	1.3

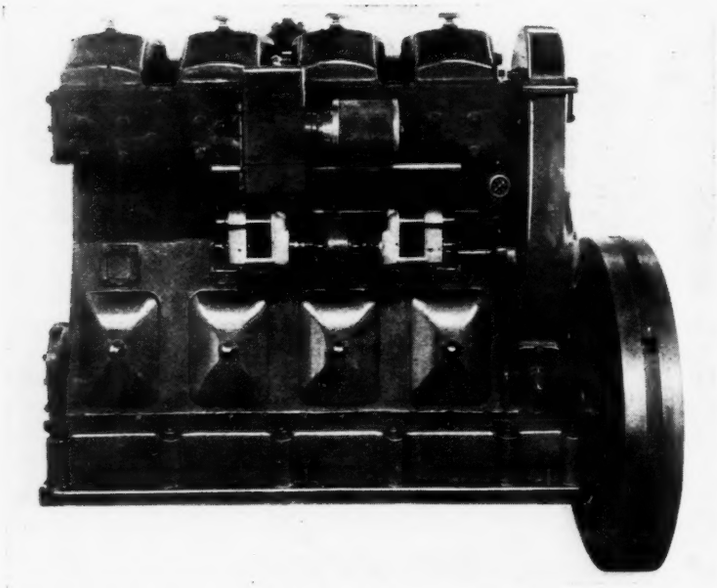


Fig. 1—Convertible 6x9-in. gas engine, rated 54 b.hp. at 720 r.p.m.

HIGH-SPEED ... THEIR

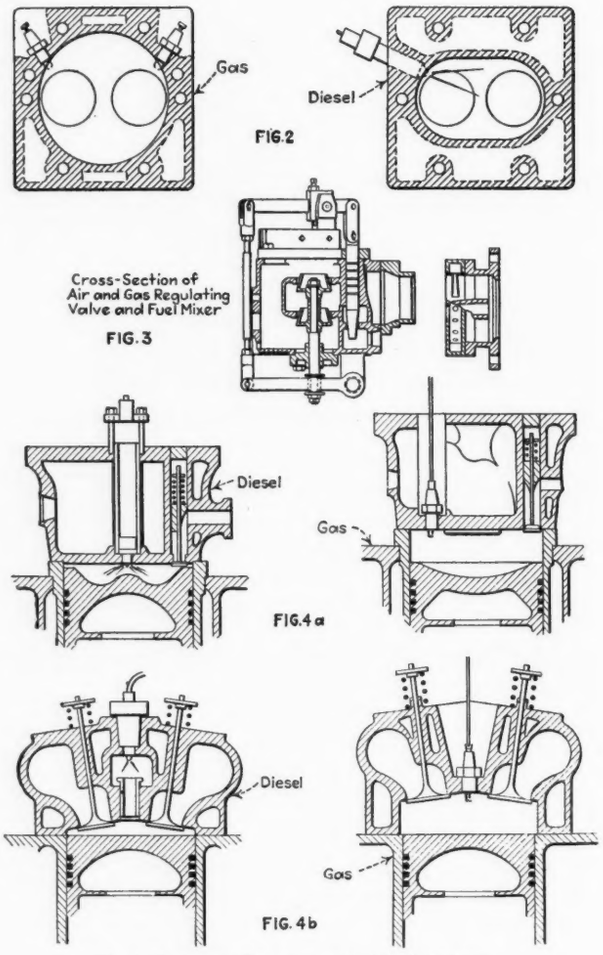
By W. M. KAUFMAN, M.E.
National Transit Pump & Machine Co.

Development, design and economy data on these increasingly popular units

THE effect of the present economic trend upon oil and gas engine design is shown by introduction of engines capable of operating on either liquid or gaseous fuels. Simplicity, increased production of a minimum number of parts and essential features of interchangeability make such an engine an attractive manufacturing proposition, at the same time increasing the range of application of a standard unit.

With the growing use of natural gas and extension of pipe lines from established or newly discovered gas fields, the small diesel engine, which found a good market in isolated or small communities, begins to meet a strong competitor. Advantages of the multi-fuel engine are elimination of fuel-oil storage and having gas on tap, much as purchased electricity. Also, extension of refinery practice to gasoline reforming units, and the desirability of conserving steam for process work, has caused the utilization of by-product still gases as engine fuel for hot-oil pump drives in cracking plants. Not only has this type of drive proved convenient in this respect, but the cost per unit power developed is cheaper by approximately 60 per cent of that for motor or steam drive, as determined by P. M. Robinson, Pennzoil Co. A process cost of 18 cents per 1,000 cu.ft. of 1,500 B.t.u. still gas is charged against this fuel in the cost analysis.

Another reason for the convertible engine is the demand for it in the oil fields where, during certain stages of drilling, either gas or oil is not available. Gas and gasoline engines are used extensively in this work. The question whether a gas engine converted to a diesel can be as efficient as a strictly individual design is answered affirmatively by experience and extensive tests. However, this is true only when the original design is developed with the various compromises made to insure correct combustion spaces for both types. The engine must be primarily designed as a diesel, thus giving the frame and reciprocating parts of the gas or gasoline conversion sturdy construction. The combustion chamber of the engine is made to give the requisite turbulence, cooling, and valve-port construction.



Typical convertible gas and diesel designs

Only two or three commercial convertible engines are at present available in the high-speed stationary type. The method of one builder for converting the gas to full diesel requires changing only cylinder heads, gas-mixing valve, and electrical ignition, to a fuel-injection

CONVERTIBLE GAS-DIESELS

OPERATING CHARACTERISTICS

system. The valve area in the diesel is the same as for the gas engine, permitting interchangeability of valves and valve springs. Estimated time for making a complete change to operation on fuel oil is two hours. Another builder changes heads, and also pistons, using a shorter piston on the gas engine. The diesel cylinder head has smaller valves, the nozzle being centrally located in the head and the piston top made to conform with the symmetrical pattern secured. On the gas engine, either single or twin ignition is used. The advantages of twin ignition for continuous heavy-duty performance are chiefly in having the spare magneto to prevent shutdowns.

In Fig. 1 is shown a convertible gas engine of 6-in. bore and 9-in. stroke, rated 54 b.hp. at 720 r.p.m., having twin ignition, two magnetos, one with an impulse coupling for easy starting. Turbulence in the combustion chamber, Fig. 2, is secured by an eccentrically located inlet port which causes the gaseous mixture to swirl around the cylindrical space. Two spark plugs placed almost diametrically ignite the explosive charge. A metering type regulating valve, Fig. 3, which proportions the mixture ratio of gas and air and mixes by means of a slotted grid and whirler, supplies fuel to a common manifold. Normal economical operation is secured with 2 to 4 in. of water suction in the gas supply pipe. The gas valve is adjustable so that gas-air ratios from 5-1 to 16-1 are possible.

In converting to the diesel cycle for operation on fuel oil, the conical top of the piston is used to produce a high degree of turbulence at the center of the combustion space, by means of a high-velocity jet of air forced from opposite restricted sections of the clearance pocket. The single fuel nozzle in the chamber projects two sprays across the top of the piston, passing through the turbulence zone. For operation on other fuels, such as gasoline, modification of the gas-engine intake to accommodate a carburetor is necessary. Where liquid butane is supplied in tanks for engine fuel, with proper heat processing and cutting down to a very lean mixture, it may be piped directly to the gas-engine mixing valve.

Another type of convertible engine is shown in Fig. 4. The gas engine has one spark plug at the top of the combustion chamber. The cylinder head is flush and the piston is short. The diesel engine head is similar to that for the gas engine, but has a spray nozzle in place of the plug. The piston has a hemispherical top and is longer above the piston pin, giving the higher compression of the diesel cycle. The change in compression pressure is from 120 lbs. per sq.in. in the gas engine to 450 lbs. per sq.in. in the diesel. This engine is rated at 30 b.hp. per cylinder at 550 r.p.m. The gas-mixing valve is of the balanced type having a single adjusting screw which is rotated for regulating quantity of gas. Ignition is furnished by magneto or battery.

Another design, but of a medium-speed engine having the convertible feature, is of interest. Here the head is changed and the ignition equipment replaced by fuel pumps. The spark plug is centrally located and the valves slightly inclined. In the diesel, a precombustion chamber is used into which the fuel is injected, the explosive charge entering the main clearance space through a series of jets in the bottom of the cup.

Of interest to the power plant engineer are the relative operating characteristics with reference to economy and torque. Progress in securing high over-all efficiency in modern high-speed vertical gas engines is shown in recorded test data, Fig. 5. The fuel used was natural gas having the constituents shown in Table I. Fuel consumption, based on average performance, is 9,500 B.t.u. per b.hp. per hr., or a thermal efficiency of about

Performance data on convertible units

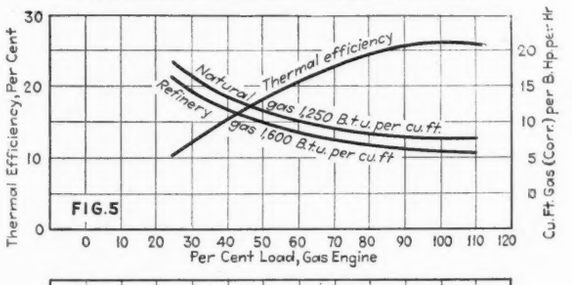

Thermal Efficiency, Per Cent
Natural gas 1250 B.t.u. per cu.ft.
Refinery gas 1600 B.t.u. per cu.ft.
Cu.Ft. Gas (Corr.) per B.Hp. per Hr
Per Cent Load, Gas Engine

FIG. 5

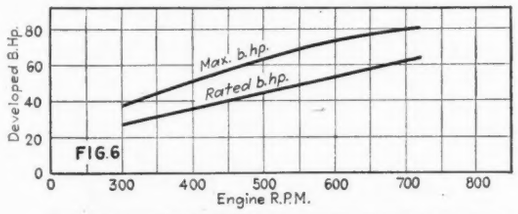


FIG. 6

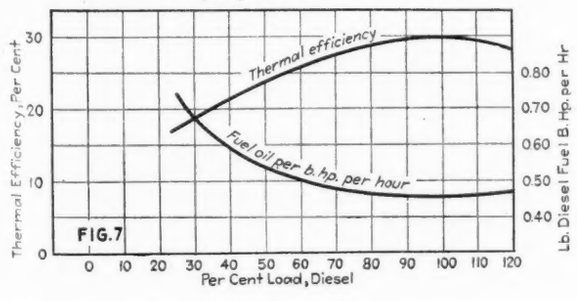


FIG. 7

TABLE I

Penn. Natural Gas Per Cent by Volume		Refinery Gas Per Cent by Volume		Diesel Fuel Oil	
Methane	63.90	Methane	37.60	Gravity	36- 40
Ethane	25.30	Ethane	30.20	Flash	225-230
Propane	6.65	Propane / Propylene	27.60	BTU	19,000 per lb.
Butane	2.71	Isobutane	2.40		
Pentane	0.75	Pentane	.20		
Hexane	0.19	Butylene	2.00		
Nitrogen	0.50				
	100.00		100.00		

27 per cent. The torque curves and brake m.e.p. represent commercial ratings, Fig. 6.

Fuel was supplied to the engine through a Crawford sensitive regulator reducing the gas pressure to 2-in. vacuum. Spark advance for optimum conditions was 30 to 40 deg. It will be observed that with natural gas, an overload margin of over 30 per cent was developed.

Refinery operation on still gas showed extremely high economy. The constituents of reforming unit gases derived from the cracking process are given in Table I. The increase in maximum power over natural gas was 15 to 20 per cent, the reduction in fuel consumption approximately 15 per cent. In high-speed stationary gas engines of small bore, the operation on either of these fuels did not require any change in engine compression. A normal compression of 120 lb. per. sq.in. with a spark advance of 30 deg. showed no ignition knock with the higher B.t.u. gas, the mixing valves being set for a uniform and relatively leaner mixture. Where natural gas is mixed with manufactured gas, as is the case in present industrial practice, the operating cost is increased, but special industrial rates for power plants make the comparison with other types of power very favorable.

When converted to the diesel cycle, the necessary auxiliary equipment must be considered, such as supply tank, fuel-oil filters, day tank, hand pumps, and exhaust pyrometers. The jacket-water cooling supply, if adequate for the gas engine, is sufficient for the diesel owing to the smaller heat loss to the jacket. Fig. 7 shows the fuel consumption curve of the converted high-speed diesel. With proper combustion control, maximum loads of 25 per cent over rated capacity are obtained. At extreme overloads, however, smoky exhaust will develop. As in the gas engine, where excessive loads stall or cause rapid speed drop, so in the diesel, exhaust will become smoky and operation faulty. Maximum load ratings, therefore, are based on the point where exhaust is clear or just slightly smoky. The diesel fuel oil used is given in Table I. Injection was at 3,000 lb. per sq.in., with approximately 10-deg. injection advance.

The comparative operating cost has been discussed in recent papers for slow-speed types. Based on the above data for high-speed engines, a fuel consumption of 0.45 lb. per b.hp. per hr. develops the equivalent of 9,500 B.t.u. of 1,250-B.t.u. per cu.ft. natural gas. Knowing the gas rates for a definite vicinity, and fuel-oil charges, costs may be computed. From the data presented, the operating characteristics of the high-speed convertible gas-diesel engine indicate that such designs are commercially practicable, and that economical operation is possible where application of the Otto or Diesel cycle conversions of the high-speed type are used.

FITNESS NOT INCLUDED IN GUARANTEE

By LESLIE CHILDS

Attorney-at-Law

WHEN steam plant equipment is purchased on specifications furnished by the buyer, guarantee of the equipment under these specifications does not necessarily guarantee that such equipment will satisfy the purposes of the buyer. Unless the seller also expressly guarantees the fitness of purpose, or the facts imply such a guarantee on his part, he will have complied with the contract when he furnishes equipment meeting the specifications supplied. This is a legal point for steam plant owners and operators to have in mind when they are buying equipment to specifications. As an example of judicial reasoning, the following case is cited:

The defendant required a fan to operate in connection with a battery of four 1,000-sq.ft. boilers. The following specifications were written and sent out to fan manufacturers who might bid: "The fan shall have a maximum capacity sufficient to permit the burning of enough Swatiska coal to permit the simultaneous operation of at least three of the boilers at 200 per cent rating, and shall be capable of delivering to the base of the stack, when operated at normal capacity, the products of combustion of the three boilers operating at normal load.

"It shall have a maximum capacity of at least 20,000 c.f.m., and when operated with flue gas at approximately 600 deg. F. and outside air at approximately 80 deg. F., the maximum available draft, due to the fan, and measured in the furnace of the boiler farthest from the stack, shall be at least 0.05 in. of water pressure."

The plaintiff, whose bid to supply the fan was accepted, in due time delivered the equipment in strict compliance with the specifications, but upon trial it failed to meet defendant's requirements, it being of insufficient capacity to sustain the operation of three boilers at the same time at 200 per cent rating. The defendant refused to pay for the fan on the ground that the plaintiff's guarantee of the specifications implied a guarantee of fitness. The dispute culminated in the plaintiff filing suit for the price of the fan. The defendant counter claimed for damages for breach of guarantee. In deciding the case, the language of the court was: "It is conceded that at no time prior to the delivery of the fan was plaintiff's attention called to the fact that it was to be used in connection with the operation of four 1,000-sq.ft. boilers. There is no dispute on the part of the experts testifying in the case that the capacity of the fan is to be measured by the number of cubic feet of gas per minute which it can handle, and that in order to design a fan, to permit simultaneous operation of three boilers at 200 per cent rating, it is necessary to know the size of the boilers.

"Plaintiff contends that because the specifications of the fans were silent with respect to the size of the boilers, but did require a maximum capacity of at least 20,000 c.f.m., it was justified in assuming that the engineer who prepared the specifications had figured out the necessary capacity of the fan to be 20,000 c.f.m.

"We see no escape from this conclusion. It being conceded that the fan had a maximum capacity of at least 20,000 c.f.m., plaintiff complied with the guarantee, and there is no basis for defendant's counter claim." In conclusion, the court directed judgment for the plaintiff for the price of the fan.

He *ASKED FOR* and *TOOK*

FREE ADVICE THAT SAVED 10%

—And both parties profited.
It pays to ask the man who knows.

By FRANK A. KRISTAL
Mechanical Engineer,
New York City

IN GENERAL, when a prospective purchaser plans to buy a centrifugal pump, he determines the capacity required and the total head against which the pump will operate. These data are then sent to several pump companies for bids, and the most attractive proposition is selected, based upon efficiency and price.

This is the conventional method of purchasing centrifugal pumps, and is usually satisfactory. However, this procedure does not give the purchaser the advantage of pumping experience which the pump company's engineers have available. A more satisfactory method would be to submit a complete layout of requirements and permit manufacturers' engineers to make recommendations. The following example will serve to illustrate the results which may be obtained:

A large sugar company was planning to purchase a number of irrigation pumps. Each was to be installed on a ledge in a well about 10 ft. below the land surface, and draw water from a suction well about 15 ft. lower down. It was intended to purchase horizontal-shaft centrifugal pumps and install them as in Fig. 1. Specifications called for this type of pump, designed for 3,500 g.p.m. against a 32-ft. total head.

The manufacturers quoted on 12-in., single-stage, double-suction pumps, all piping being figured as 12-in. diameter. Taking the layout, Fig. 1, with piping friction estimated on the basis of 4.1 ft. per 100 ft. and with a 12-in. elbow taken as equivalent to 40 ft. of straight pipe, elbow friction amounts to 4.9 ft. of head.

One manufacturer offered an alternative unit having bottom suction and horizontal discharge, Fig. 2. With this arrangement, the suction elbow could be eliminated, saving 1.64 ft. friction head, or approximately 5 per cent of the total head.

Assuming that the pumps, Figs. 1 and 2, were of equal efficiency, say 75 per cent, the power for the design of Fig. 1 comes to 38 hp. and that for Fig. 2, 36 hp., a 2-hp. saving obtained simply by changing the pump arrangement.

A second manufacturer submitted a proposition using a standard single-stage, double-suction pump turned through an angle of 90 deg., standing it on the bedplate on its suction flange, Fig. 3. A slight alteration made in the suction flange allowed it to support the pump and connect to the suction piping. This arrangement eliminated two elbows, only the top one being required, and the head was reduced 3.28 ft. On this basis, the total head would be decreased to 28.72 ft. and the power to 34 hp., a saving of 4 hp. over that required for the layout in the original specifications.

Since the customer was planning to install a number of these units, the saving of more than 10 per cent in power was attractive enough to win the order.

This indicates the advantages to a customer of consultation with the pump manufacturer regarding a proposed installation. In the arrangement, Fig. 3, no new principles of design are involved, only the application of simple hydraulic principles.

Fig. 1—Conventional pump arrangement, horizontal suction and discharge. Fig. 2—Pump arranged for vertical suction and horizontal discharge. Fig. 3—Pump arranged for vertical suction and vertical discharge

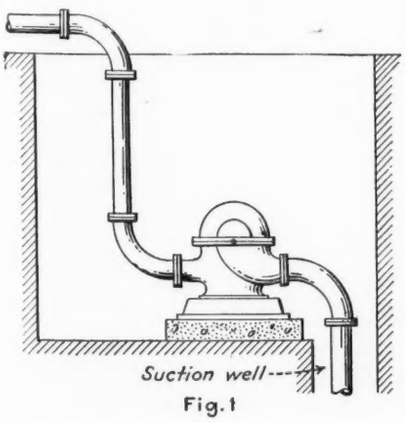


Fig. 1

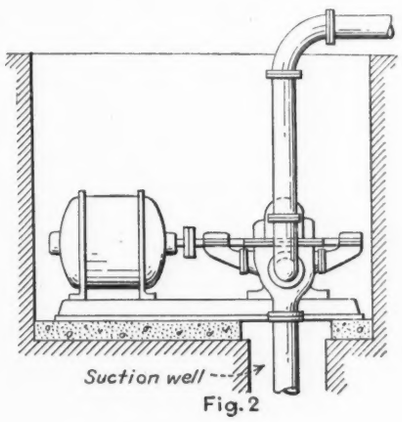


Fig. 2

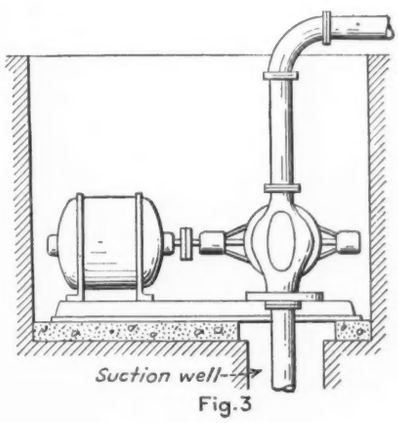


Fig. 3

WISE CHANGES IN BEARING OIL GROOVES

PAY BIG DIVIDENDS

By EZRA K. NICHOLSON
Cleveland, Ohio

Reduced maintenance costs, improved lubrication and better operation resulted when changes were made in both location and shape of oil grooves in crankshaft and crankpin bearings of large heavy-duty gas compressors

HIGH maintenance costs led to an investigation that resulted in relatively simple, inexpensive changes in lubricating a number of heavy-duty compressors at the DuPont Company's Belle Works. These compressors furnished gas to high-pressure synthesis apparatus sensitive to sudden changes of gas flow. The processes operated continuously, so that it was highly desirable that the compressors operate with as few service interruptions as possible.

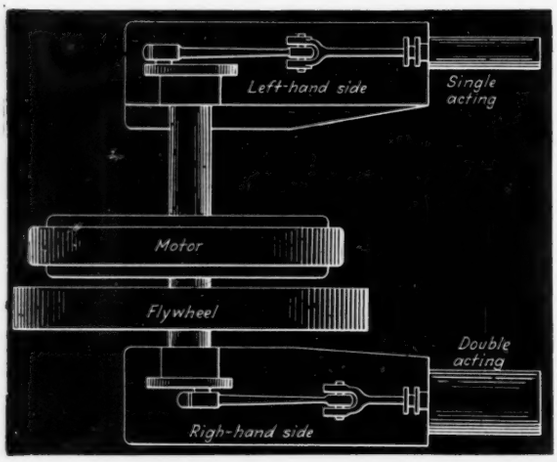


Fig. 1 (Above)—General plan of duplex compressors driven by 2,000-hp. synchronous motors

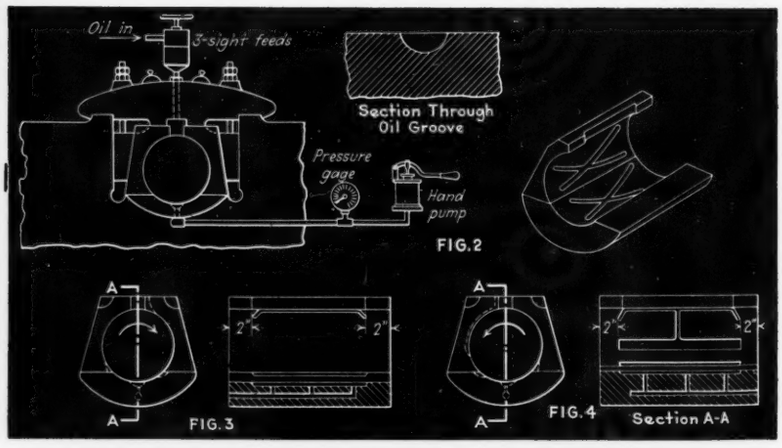
The compressors are horizontal, duplex type, with a double-acting cylinder on the right-hand side and a single-acting cylinder on the left-hand side, Fig. 1. They are driven by 2,000-hp. 120-r.p.m., engine-type, synchronous motors and require an especially heavy flywheel because of the unsymmetrical cylinder arrangement.

Their main bearings, 20 in. in diameter by 36 in. long, required frequent adjustments, especially during warm weather. They were supplied with flood lubrication through three points of feed. Connections under the shaft permitted oil to be forced by hand pump before starting and also permitted forcing additional oil into the bearings during operation. The arrangement of these bearings and the original oil grooving are shown in Fig. 2. Bearing pressures, when the compressors were running, varied from 108 to 370 lb. per sq.in. on the right-hand side and from 92 to 317 lb. on the left-hand side.

A pressure gage installed between the hand oil pump and oil grooves in the bottom of the bearing indicated a pressure of 20 lb. per sq.in. This was much lower than actual unit bearing pressure, indicating a poor lubrication condition, and it was decided to make changes in these bearings in order to:

1. Admit the oil at the point of minimum pressure.
2. Shape the oil grooves to favor forming of an oil film between shaft and bearing.
3. Locate the grooves so that they would not connect areas of high bearing pressure with areas of low pressure.

Curves of total bearing pressure were plotted, using indicator cards, effective areas of pistons, calculated inertia forces of reciprocating parts, and dead weight of rotating parts. Points of minimum bearing pressure were determined from these total-pressure diagrams and oil grooving laid out as shown in Figs 3 and 4.



Figs. 2 to 4 (Right)—Arrangement of crank-shaft bearings, original oil grooves and grooves in remodeled bearings

Attention is called to the contours of the oil grooves, as well as to the manner in which the edges of adjacent parts of the bearings are chamfered. The contour of the oil groove directly under the centerline of the main shaft was also provided with a long trailing feather edge. The difference in groove arrangements in the bearings takes care of the difference in direction of loading.

While pressure readings taken with the original oil grooving gave about 20 lb. per sq.in., a pressure of approximately 70 lb. was obtained with the new oil grooving. Pressures obtained when using the new grooving correspond closely with the unit bearing pressure at that point as calculated from pressure diagrams.

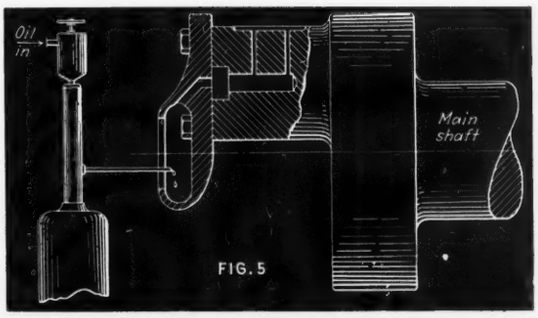
Oil grooves should not approach the outside edges of bearings too closely. In this particular case, groove ends come within 2 in. of bearing edges. Only in exceptional cases, or small bearings, should oil grooves be allowed to come closer than 1 in. from the bearing edge.

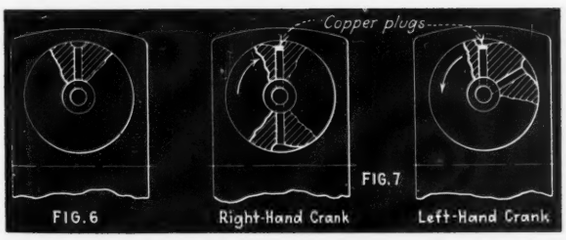
These changes in oil grooves reduced the bearing adjustments to about one-fourth those formerly required, and the tendency to run warm was largely eliminated. Interruptions to operation were also reduced, with an attendant increase in operating efficiency of compressors and synthesis units.

Crank pins of these compressors, 14 in. in diameter by 13 in. long, were originally supplied with open-type, banjo, centrifugal oiling devices, Fig 5. The two halves of the crank bearings had the conventional cross grooves, and the crank pins were drilled and grooved as in Figs. 5 and 6.

Pressures in the crank bearings on the right-hand side varied from 1,320 lb. on the head-end half to 530 lb. per sq.in. on the crank-end half. These bearings were a constant source of annoyance, requiring frequent adjustment, and would suddenly run hot.

It seemed possible that a portion of the crank-bearing trouble could be eliminated by obtaining more effective lubrication. A study of pressure conditions existing in the crank bearings was made, and diagrams for total pressures on crank pins were constructed. From these





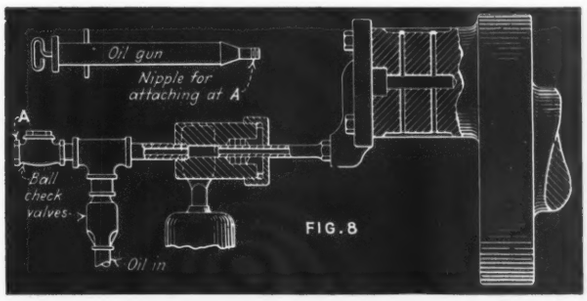
Figs. 5 and 6—Original oil system for crankpin bearings.
Fig. 7—Old and new oil ways in crank pins

it was decided that the location of the oil groove in the right-hand crank pin should be diametrically opposite its original location. It was also decided that the groove should have a long, trailing edge, as in Fig. 7, to allow a film of oil to be drawn between the crank pin and the bearing by the pin's rotation.

On account of the compressors' construction, the correct oil-groove location was only 3 in. away from the main-shaft centerline. It was obvious that the open-type, banjo, centrifugal oiler originally installed could not supply oil to this point. It was therefore necessary to devise other means of lubricating the right-hand crank pin from the 30-lb. oiling system used.

Fig. 8 shows the oiling method used. The stuffing box was made stationary to allow adjustment while the compressor was running, and it was also mounted to be self-aligning. Provisions for an emergency supply of cool oil were made by placing ball check valves in the oil lines as indicated, and by brazing a short pipe nipple to the end of an oil gun for connecting to *A* when necessary.

The correct location of the oil groove in the left-hand crank pin was found to be 52 deg. clockwise from its



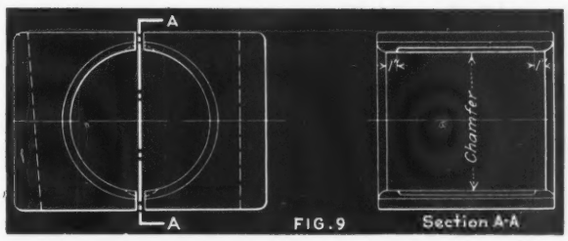


Fig. 8—Remodeled oiling system on right-hand crank pin.
Fig. 9—Crank-pin bearing

original location, Fig. 7. Since this point is well removed from the main-shaft centerline, it was not necessary to use the closed-type oiling device, Fig. 8, on this side of the compressor.

Copper plugs were placed in the oil holes to the original grooves and they were faced off to a point below the surface of the crank pins. Trailing edges of the original oil grooves were feathered, as in Fig. 7, to prevent the scraping-off action of the original sharp edges. Oil grooves were omitted from the bearings, but they were provided with chamfers as in Fig. 9.

While these changes did not entirely eliminate the bearing trouble on the right-hand side due to the extremely high pressures (more than twice the accepted maximum allowable for normal operation), they did materially reduce adjustments and bearing replacements to less than one-half those formerly required. Bearing adjustments and replacements on the left-hand side were almost eliminated.

ADDING CIRCULATING TUBES

By E. M. BROWN
Combustion Engineer, Central Heating Dept., Detroit Edison Co.

A RECENT experience with one of the large bent-tube boilers at Beacon Street Heating Plant[1] of The Detroit Edison Company has shown the important influence which the arrangement and number of circulating tubes connecting the upper drums in boilers of this type may have upon the dryness of the steam delivered. In this case the addition of several rows of upper circulating tubes reduced the moisture content of the steam at high loads, from 5 to less than 0.5 per cent.

Differing from the usual W-type boiler in several important respects, the unit tested has four 48-in. steam drums, all placed at the same elevation, and two 54-in. mud drums. There are 53 longitudinal rows of tubes and 21 circumferential rows from each mud drum to the steam drums. Of these, 12 rows lead to a center steam drum and 9 to an outside steam drum. Each center steam drum is connected to an outside steam drum by two full rows (106) of water circulators, and, in the original installation, by 36 steam circulators. All tubes are 3¼-in. outside diameter, seamless steel.

The boiler has a total heating surface of 41,196 sq. ft., and operates at 150 lb. pressure. Feedwater is delivered in the outside steam drums to simple open troughs, each of which contains a submerged distribution pipe.

Four water columns, one at each end of each center steam drum, are provided. Visible portion of the gage glass is about 14 in. long, and high- and low-water alarms are set to sound at 4 in. above and below the center of the gage glass. Center of the columns, which corresponds with the center of the gage glass, is 10½ in. below the center of the center steam drums, as shown by Fig. 1.

Fig. 1 also indicates the water level in the drums with respect to the gage glass and water circulating tubes. When the water level is 4½ in. below the center of the drum, both rows of water circulating tubes are completely submerged, but when the water level is 13½ in. below the center, the ends of both rows of water circulators are uncovered. It is thus possible, that the water-circulating tubes act as steam circulators, if the water is maintained at a sufficiently low level.

Moisture determinations of this investigation were made with throttling calorimeters using standard A.S.M.E. sampling tube installed in the main steam line. Values so obtained were periodically checked with separating calorimeters and were found to agree within less than ½ per cent. It is recognized that the method of extracting the samples for moisture determinations is not beyond criticism, especially at high steam velocities, but it is felt that they have comparative value, since the measurements were always made at the same location and the samples extracted in the same manner. Three other sampling tubes were installed inside of the boiler in an attempt to determine the source of wet steam. One sampling tube was placed in one of the steam-circulating tubes between a center and outside drum, another in one of the water-circulating tubes and the third in an outside steam drum.

In performing the tests, the water level in the boiler, as indicated by the gage glass was held constant while boiler load was varied from 200,000 to 500,000 lb.

[1]Described Nov. 23, 1926, page 762.

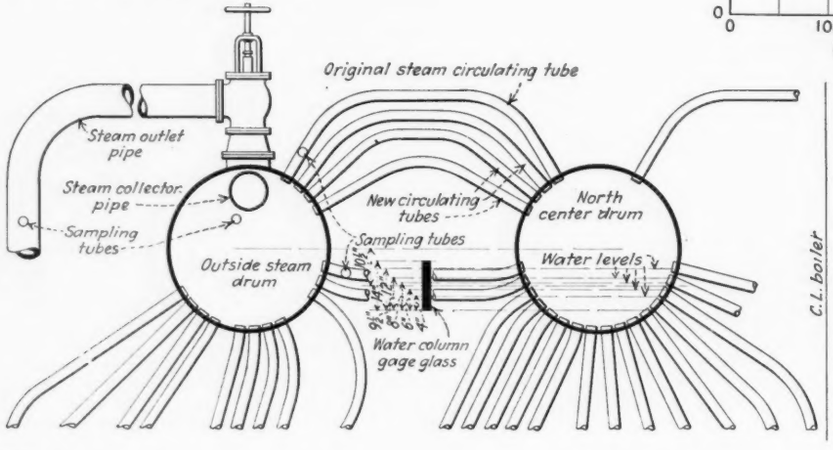


Fig. 1 (Left)—Cross-section of steam drums, showing relation between water column, gage glass, circulating tubes and water level

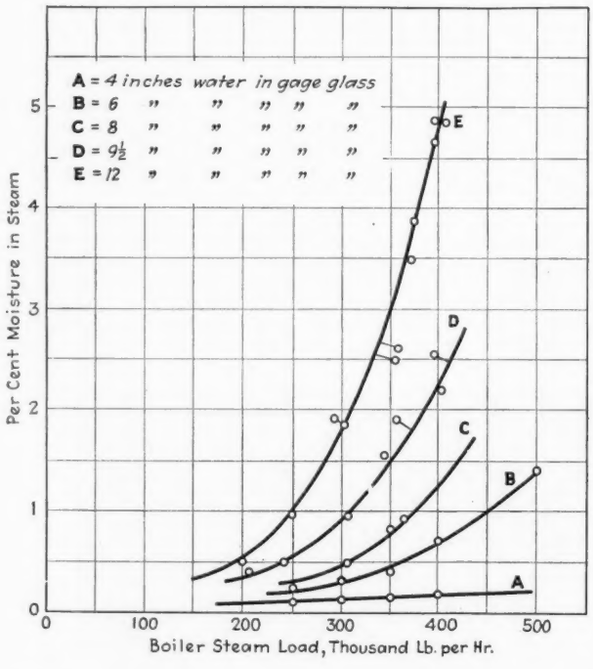


Fig. 2 (Above)—Moisture content of steam generated by boiler as originally installed

REDUCES MOISTURE IN STEAM

per hr. Several series of tests were made, in each of which the water was held at a different level. Results of these tests are shown by Fig. 2.

It is customary to carry the water slightly below the center of the gage glass, but with the water at this level, the steam contained nearly one per cent moisture with boiler loads of 400,000 lb. per hr. Whenever the water

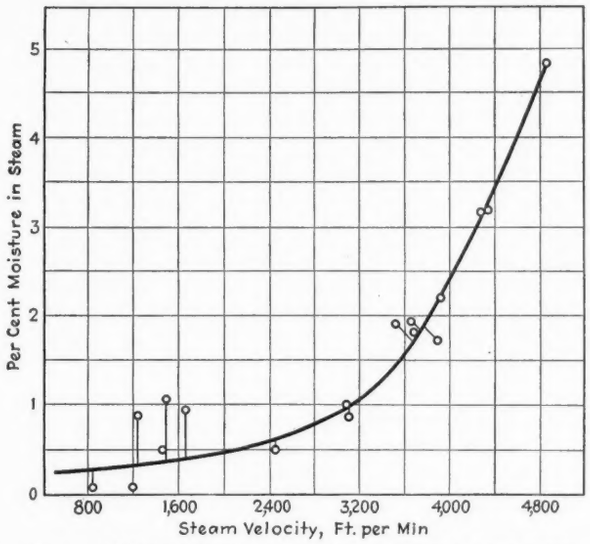


Fig. 3—Calculated velocity of steam through circulating tubes of original installation for boiler steam loads from 200,000 to 500,000 lb. per hr.

level was higher than this, the steam became very wet, as shown in Fig. 2.

Steam in the steam circulators, and that at the top of the rear drum, was always reasonably dry, regardless of water level in the center drum. It contained approximately one-half per cent moisture with steam load of 400,000 lb. per hr. With lower loads, dry steam was found in these locations.

Samples taken from the upper water circulator showed nearly dry steam with low-water level in the drum and a low steam output. When the load was increased to the maximum, with low-water level, the moisture content became very high and could not be determined. With high water in the gage glass, the end of the circulating tube in which this sampling tube was located was apparently submerged in the center steam drum. The sample, however, seemed to be wet steam rather than water alone.

These determinations of moisture indicated that steam passing through the water-circulating tubes at high velocity carried water with it out into the main steam line. When the water level was kept low, probably steam was passing through all water-circulating tubes. The steam velocity, therefore, was low, and but little moisture was carried by the steam. As the water level was increased, some of the water circulators were submerged and the steam velocity through them increased. At this higher velocity, the steam passing through the water circulators carried large quantities of moisture into the steam collector pipe.

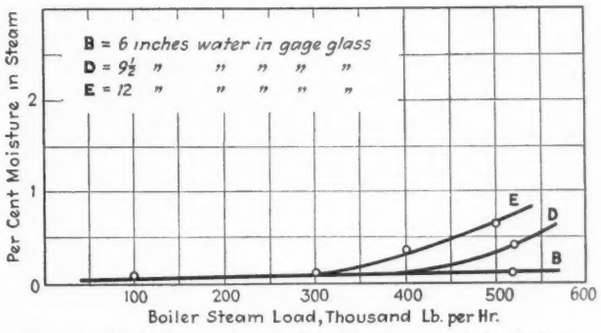


Fig. 4—Moisture content of steam generated by boiler after installing 167 additional circulating tubes

If the wet steam were caused by high steam velocities in the circulating tubes, the trouble would be eliminated, by increasing the number of steam circulators. As a first step in determining the number of additional tubes needed, a velocity-moisture curve was drawn. To determine the probable velocity of steam passing through the circulators, the amount of steam generated in the different banks of tubes was calculated from the boiler gas temperature. This showed that about 94 per cent of the steam generated was delivered to the center steam drums and passed through either the steam- or water-circulating tubes from the center to the outside steam drums. Assuming equal flow in all tubes open to the passage of steam, the velocities were determined. Using these velocities and the moisture content of the steam for the various conditions, the curve of Fig. 3 was plotted.

When the steam velocity through the circulators was less than 1,100 ft. per min. the steam delivered by the boiler usually contained less than ½ per cent moisture. We decided to install sufficient additional steam circulators to maintain this low velocity.

A survey indicated that 85 additional tubes could be installed between the two north drums and 82 between the two south drums, a total of 167 tubes. These were located in three new rows below the original steam-circulating tubes.

With the new tubes installed, calculations indicated that if the water levels were kept sufficiently low so that one row of water circulators was always uncovered, the average steam velocity through the circulating tubes would be only 1,280 ft. per min. with steam output of 500,000 lb. per hr. Although this velocity is not quite as low as was desired, it was decided to make the initial installation and see if the change actually produced the expected results.

Results of moisture tests, made after the tubes were installed, are shown by Fig. 4. With boiler loads of less than 300,000 lb. per hr., steam was nearly dry, regardless of water levels in the boiler. If the water level was kept below 8 in. in the gage glass, the boiler operating at its maximum capacity produced steam containing less than ½ per cent moisture. With water up to the high-water alarm, the moisture content was less than 0.7 per cent, at the highest steaming rate. Comparison of the curves of Figs. 2 and 4 show the marked improvement.

6 WAYS to DEFROST REFRIGERATING PIPES

By CARL WILKIE
Los Angeles, Calif.

HIGH heat transfer through refrigerating pipe coils means high suction pressure, and for each pound of increased suction pressure a saving of approximately 2.5 per cent in power is effected. An accumulation of 1½ to 2 in. of frost on coils will decrease a suction pressure of 25 lb. to 18 or 19 lb., with 15 per cent loss in power per ton of refrigeration produced. Consequently, defrosting should be seriously thought of in the design of a plant and consideration given to proper coil connections, design, location and the product to be stored under the coils.

Defrosting With Ammonia Liquid

Defrosting with warm ammonia liquid has been used for many years. It is, however, expensive and dangerous. First, the suction valve on the coil is closed and the expansion valve is opened wide. As the coil is being filled, the pipes are usually jarred so that frost falls off as fast as it melts loose. If the coil is very long, the liquid ammonia will drop below the defrosting temperature before it reaches the end of the coil. Then defrosting ceases until the suction valve is opened to let some of the cold liquid out, so it can be replaced with warm liquid.

The next step is to close the expansion valve and pump out the coil. Judgment must be exercised in this operation, for if done too rapidly, too much liquid will be drawn into the compressor. A coil containing 1,400 linear feet of 2-in. standard pipe contains 32.6 cu.ft. of vapor. The weight of liquid ammonia under 170 lb. gage pressure is 36.85 lb. per cu.ft. Therefore, there will be 1,201 lb. of liquid to get through the compressor. This amount of liquid expanded into the suction line would produce 9,790 cu.ft. of gas at 20 lb. pressure and is equivalent to 2.4 tons of refrigeration.

Practically all evaporating coils are of standard butt-welded pipe. Some coils are old and pitted and will not stand condenser pressure. In case a bad leak develops, the loss of ammonia is considerable, as the liquid can only be removed as fast as the compressor can displace it safely.

Removing Frost With Scrapers

Removing frost with scrapers is rather expensive, as it requires considerable labor and the result is seldom satisfactory. As a rule, there is a coating of hard ice which clings to the pipe wall and is seldom moved. It is also necessary for the workmen to move scaffolds from place to place, as coils are usually located on the ceiling.

Hot Gas Method

Defrosting with hot gas taken from the discharge side of the ammonia compressor is the cheapest and safest method for removing frost, especially where the coil is fed from the bottom with the suction-outlet at the top. To defrost by this method, close the expansion and suction valves, open the hot gas valve. The evaporating coil is now working as a condenser. A 1,400-ft. coil can be defrosted in approximately 15 min. When through, close the hot-gas valve and open the suction valve, as the coil does not contain sufficient liquid to slop over into the main suction line. It requires approximately 70,000 B.t.u. to defrost a 1,400-ft. coil.

When defrosting with hot gas, it is not necessary to put more than 60 lb. pressure on the coil. It is important to have an ample volume of gas up to the coil, and the gas inlet to a 1,400-ft. coil should not be less than 1¼ in. The main thing to keep in mind is to get the frost off as quickly as possible to avoid drip from the coil. In case the coil is fed from the top, it will be necessary to throttle the liquid ammonia out in the same manner as when warm liquid was used.

Duplicate Coils

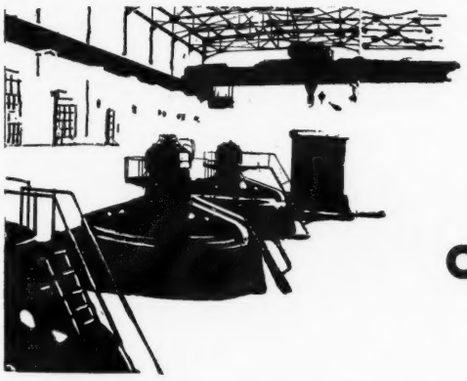
A common method of defrosting brine coils where the temperature is maintained above 32 deg. utilizes duplicate sets of coils installed in each room so that one unit may be shut off at all times. The coil not in operation will defrost in a short time due to room air temperature being above 32 deg. Defrosting in this way is satisfactory, as there is no labor attached to the method. but the first cost is high.

Warm Brine

There is available equipment for heating brine electrically. The heating unit, small centrifugal pump, gage and thermometer are installed on a truck and can easily be moved about the plant. When warm brine is circulated for defrosting, the expense of scaffolding is eliminated, as the coils can be jarred slightly and the frost will fall off, providing the frost is not allowed to form a solid mass. Coils should be defrosted before the frost on one pipe meets that on another.

Defrosting Showered Coils

Showered coils are being used extensively in a number of plants, and one would imagine that the trouble of defrosting would be eliminated. This, however, is not the case. In case the coils are working up to capacity, a severe shower of brine is necessary to keep the frost from accumulating, and in case the salometer reading is too high or too low the brine itself will freeze to the pipe.



IMPROPER ATTENTION CAUSES BEARING FAILURES on HYDRO-ELECTRIC units

By RAY BARR GLEN
Oakland, Calif.

THRUST bearings for vertical hydro-electric units, even though they may have to carry tremendous loads, are highly reliable if kept properly lubricated. If lubrication is inadequate, even for a short time, the bearing may fail. Obviously, the lubrication system is vital and should be given careful attention. Mistakes may prove very costly.

Here Are Examples:

On a large vertical hydro-electric unit, the thrust bearing failed shortly after the unit had gone into regular service. The bearing was repaired and the unit put back into service again without any further trouble. The cause of the failure remained a mystery for some time until it was learned that the operator, when changing from one lubricating-oil pump to another, had not opened the discharge valve for the incoming pump. Consequently, when the outgoing pump was stopped, oil could no longer be delivered to the storage tanks. Oil flowed by gravity to the bearings from these tanks, but they were not equipped with low-level alarms. When the tanks became empty, the oil level in the bearing housing became so low that the bearing overheated. About the time the bearing failed, the hydraulic operator discovered that the pump discharge valve had not been opened. It was immediately opened, and bearing oil level came up to normal. This condition was found when an inspection was made.

In another case, after two years of service a thrust bearing was found to be running dangerously hot. The cause of the high temperature was not evident, and three other identical bearings were operating satisfactorily. After dismantling, the bearing surfaces were found to be pitted and roughened, due to shaft currents. It was then discovered that the bearing insulation had been covered with a paint that was a fairly good conductor. This paint had been scraped off the insulating surfaces on the other units. After the bearing was repaired, and the insulation restored, no further trouble was experienced.

Each of these bearings was equipped with a graphic thermometer. When the charts were investigated it was found that the hydraulic operators had for some time previously discontinued changing them, they apparently feeling that temperature records were unnecessary. As a result, pertinent data were not available.

In another station, thrust bearings overheated because of excessive foaming of the oil, making impossible the formation of the required oil film. This trouble was easily corrected by increasing the depth of oil above the bearing.

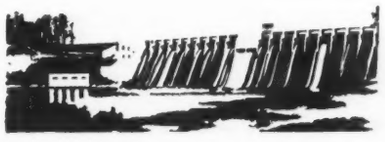
About an hour after a large vertical waterwheel generator was synchronized, the switchboard operator saw that the bearing housing at the very top of the unit wobbled. The unit was stopped and the babbitted surface of the lower guide bearing was found to be completely destroyed. In this case the hydraulic operator had forgotten to turn oil into the lower guide bearing until some time after the unit had been started.

On a large horizontal-shaft unit, one bearing overheated. In this plant, it was the practice to admit oil under the shaft at 300 lb. pressure when starting. In this way, a film of oil was always quickly formed between the shaft and bearings to make starting easy. On one occasion, the attendant forgot to close the oil supply valve at one bearing when the high-pressure pump was stopped. This allowed the oil supplied to the bearing for regular lubrication to flow back through the pump. Fortunately, the fault was discovered before the bearing was badly damaged. Repetition of this trouble was prevented by the installation of a check valve in each bearing high-pressure oil supply line.

One bearing on a small hydro unit that had to be kept in service gradually increased in temperature until the danger point was reached. To avoid a shut-down, the bearing was covered with burlap kept wet by a stream of cold water. When the unit was taken out of service weeks later, the bearing was cool, and an inspection indicated that repairs were not necessary, the trouble having disappeared of its own accord.

Cotton Waste Becomes Wick

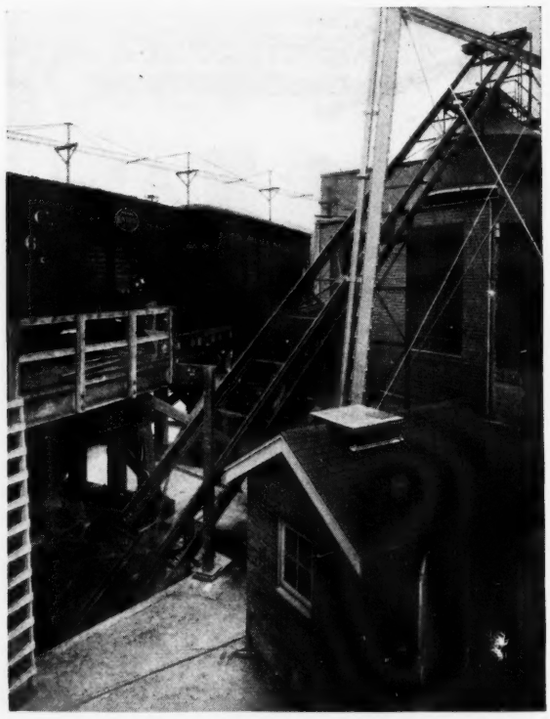
An important isolated hydro-electric plant, having but one unit, was put out of commission in an odd manner. In this case, a ball of cotton waste was drawn from an attendant's hand into the armature of the belt-driven exciter. Since a shut-down at that time would have caused inconvenience, it was planned to remove the waste as opportunity afforded. A week later, without warning, the exciter stopped, and the belt left its pulley and the generator dropped its load. The oil level in the ruined bearing was found to be below the oil rings, the waste having acted as a wick to draw the oil from the shaft.



REPEAL BRINGS MODERNIZATION TO OLD-QUAKER DISTILLERY

By H. V. SCHIEFER
Engineer
C. O. Bartlett & Snow Co.

An automatic skip hoist and weigh larry for coal handling and three new stoker-fired boilers prepare large distillery for the "New Deal"



Coal-handling equipment and boiler house, showing dead-end trestle with trackage for two cars

HANDLING of coal is just as important to the distillery operator as handling grain and finished products. A modern distillery uses a large amount of steam. A rule-of-thumb assumption is that boiler capacity to supply approximately 120 to 200 lb. of steam per hr. is required per barrel of whiskey produced per day, depending on whether grain drying and evaporating plants are installed. Thus, to produce 550 bbl. per day requires boiler capacity to deliver 1,500,000 lb. or more of steam per day. Assuming an evaporation of about 9 lb. of water per pound of coal, then a 550-bbl. plant requires 85 tons of coal or more per day.

Owners of practically all renovated distilleries are either replacing their old boilers with new ones or installing new stokers. Modern stokers have the top of their coal magazines 6 or 7 ft. from the floor, so that handling coal manually from the firing-aisle floor is out of the question. It is, therefore, not only economical but necessary to install mechanical coal-handling equipment. Many improvements have been made in coal-handling equipment since the closing of the distilleries following adoption of the Eighteenth Amendment.

Fully Automatic Skip Hoist

The fully automatic skip hoist has made its appearance. It has demonstrated that automatic coal-handling machinery can be made dependable, with consequent freedom from shutdowns and annoying and expensive upkeep and attention. Power for operating is low, and since it is fully automatic, labor cost is at a minimum.

Old Quaker Company, a subsidiary of Schenley Distillers Corp., has recently remodeled and enlarged its distillery at Lawrenceburg, Ind., not only for the production of whiskey, but also of neutral spirits and triple distilled gin. Before closing down it was equipped with three 2,250-sq.ft. Heine boilers. These have been rehabilitated and three new 5,000-sq.ft. Foster-Wheeler boilers has been installed. All six boilers are equipped with Combustion Enginering Type E stokers, designed for operating at 250 per cent of boiler rating.

The coal-handling problem in this case was to take coal from standard railroad cars and deposit it in the stoker magazines. A number of difficulties presented themselves. The old coal-handling equipment, consisting of a chain-and-bucket elevator and screw conveyor, was almost entirely disintegrated after many years of idleness without even a watchman on the grounds; for this reason it was entirely scrapped.

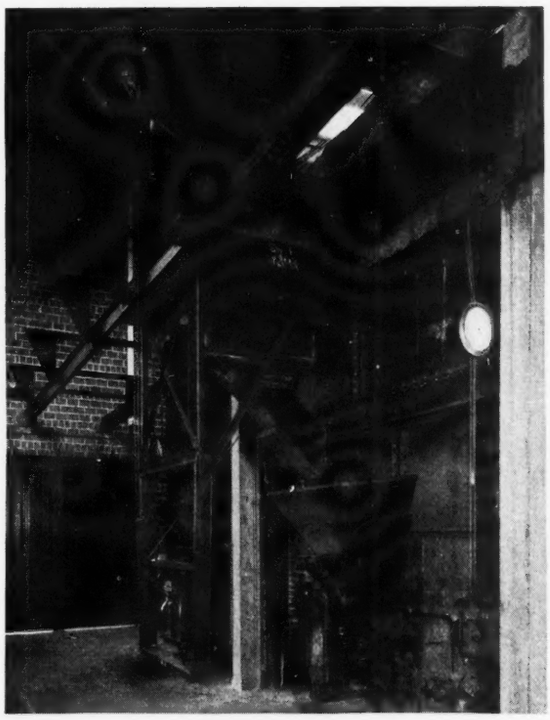
The boiler house is in a congested area and is almost entirely surrounded with process buildings. A track for unloading coal had to be built on a trestle and dead-ended at the boiler-house wall. Since more than a car load of coal a day is burned, and only one switch of cars is obtainable, it was necessary to locate the unloading point about 75 ft. from the boiler house to allow room for an extra car on the trestle.

Failure of the steam supply would be serious, so that consideration was given to the installation of coal-handling equipment that is simple and highly reliable.

With the equipment installed, the day's supply of coal is hoisted in about 3 to 4 hr., and allows the coal-handling equipment attendant the balance of the day for other duties.

Two cars of slack coal are switched onto the trestle, one of which is spotted over a 10 by 10-ft. steel track hopper. This hopper is built into the trestle and is large enough so that a regular battleship-type bottom-dump car will empty itself without further shifting. The trestle is on a slight grade and one man with an ordinary pinch bar can shift the second car to its discharging position.

A fully automatic skip hoist takes the coal up an inclined track and discharges it into an overhead bunker. This skip hoist is not only automatic in its



A 1,500-lb. larry takes coal from storage tank and weighs it to each boiler

operation, but it will start of itself when there is coal in the track hopper and will stop when the track hopper is empty.

To compensate for a delay in rail transportation or any interruption to the coal-handling equipment, overhead storage is provided. This is a round steel tank with a capacity of 125 tons, sufficient to operate the boilers for considerably more than 24 hr. The top of this tank is provided with a hinged cover for weather protection. This cover is opened and closed automatically by the skip-hoist bucket. The tank is built above the roof so that the coal-handling equipment is entirely outside and independent of the boiler room.

The bottom cone of the bunker extends down into the boiler room and is provided with a single gate for feeding the weigh larry. A standard 1,500-lb. hand-operated automatic recording weigh larry weighs the coal and distributes it to the boilers. The principal advantages of this installation are:

It is simple. A minimum of moving parts are used, consisting of a self-cleaning bucket on four wheels, some cable, sheaves and a totally enclosed hoisting engine. Maintenance is low due to the small number of slow-moving parts, and material handled does not come in contact with them.

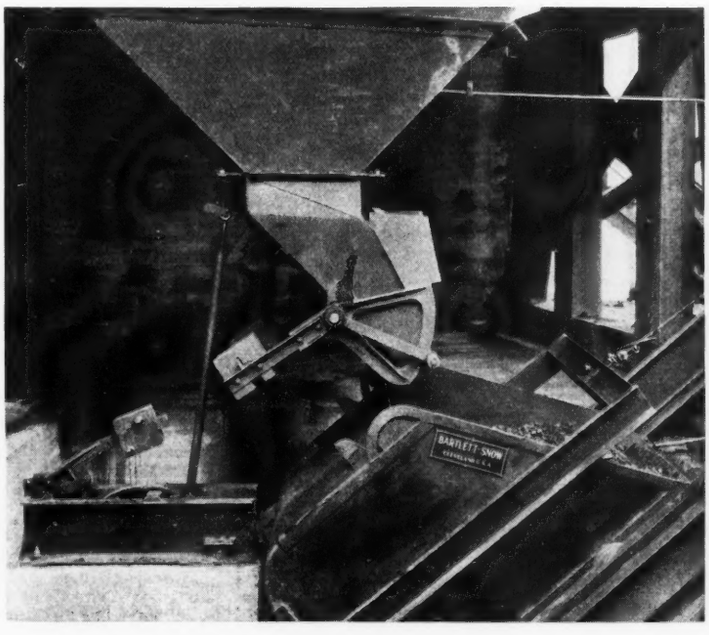
One Motor Runs It

One 5-hp. motor operates the entire equipment, and it is placed in a corner of the boiler room on the floor where it can be oiled and inspected. Coal will not freeze in the bunker in winter, since its bottom is in the boiler room. Segregation of fines and lumps in the bunker is eliminated, because the bunker is round and provided with a single outlet.

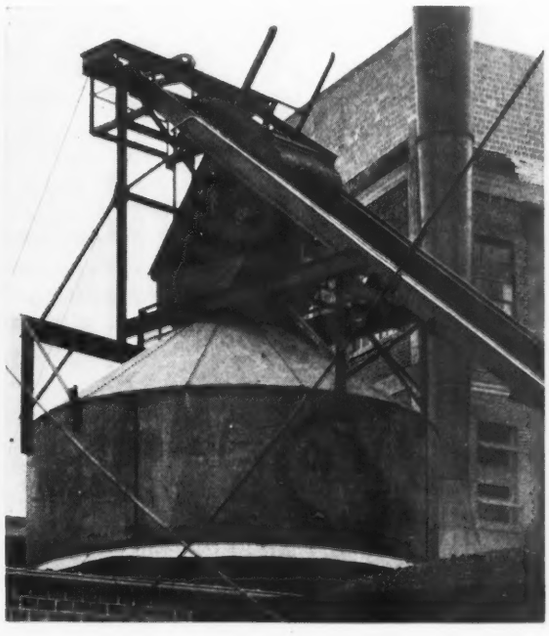
Coal dust in the boiler room is reduced to a minimum. The coal hoisting is all done outside and with this type of bunker with one outlet the coal does not get a chance to dry out. Slack coal received in open gondola cars is always more or less damp, and when it is always drawn from a single outlet it does not get a chance to dry out, as is the case with a long horizontal bunker with many outlets. The entire day's supply of coal is hoisted to the overhead bin in three to four hours, and without an experienced operator.

This rehabilitation project was designed and supervised by Carl J. Kiefer, consulting engineer of Cincinnati, Ohio. Coal-handling equipment was furnished and installed by C. O. Bartlett & Snow Co., Cleveland.

Bottom of track hopper and automatic skip-hoist loading device with the skip bucket in place for loading



Coal-storage tank above boiler house with skip in unloading position and tank cover lifted automatically



DON'T ECONOMIZE ON POWER MAINTENANCE

By HARRY M. SPRING
Waterville, Me.

DURING the last two or three years, the watchword of company management has been to economize to the limit. While this policy is a commendable lesson taught by times of slow business, it has in many instances approached the dangerous extreme of false economy. It may be all right to economize, but not to the extent that equipment maintenance is neglected. Where plant operators have followed a definite maintenance program and records are kept, the economy of this practice is so well appreciated that there is little chance of departure from it, no matter how poor business may become. Where these practices have not been carefully followed, the operating and maintenance forces may be seriously depleted, supposedly to reduce operating costs, whereas the final result is greatly increased expenditures for repairs. Lowest cost operation is obtained when equipment is put into first-class condition, and kept that way by a well-planned system of inspection and maintenance.

Make Insulation-Resistance Tests

Maintenance of electrical equipment will be greatly simplified and its operation improved by making periodic insulation-resistance tests. Results should be recorded in the form of a graph on cross-section paper. Plotting the date of the test against the value of insulation resistance provides a more apparent record than does a table of numerical values.

Many engineers use this simple rule for minimum safe values of insulation resistance. It should never be below one megohm per 1,000 volts normal machine rating, regardless of type or capacity of equipment. In my opinion, it is best to follow the A.I.E.E. standards when dealing with large motors and generators. These specify that the insulation resistance of a machine at its operating temperature should not be less than given by the formula:

$$\textit{Insulation resistance in megohms} = \frac{\textit{Rated voltage}}{\textit{Rated kva.} + 1{,}000}$$

Allowing electrical apparatus to operate until failure before repairs are made is a poor way to economize. An incident that occurred recently is a typical example of the results of neglect. A 150-hp. induction motor was used to drive a machine through a silent chain. This installation was in use for four years in a dusty location. No attention had been given to the drive as to cleanliness or lubrication. Wear and final breaking of the chain resulted. When the chain broke, it tore off its guard, wrapped around a beam and pulled the motor from its foundation. Repairs cost $250. Proper care of the drive would certainly have cost much less than that, and the machine would not have been out of service when it was badly needed.

Buying lowest-priced materials, lubricants and machine parts is a policy that generally spells trouble. The apparent savings will generally be many times lost by the failure of equipment and increased service interruptions. An example may be cited from a midwestern boiler room. Liners of special manganese steel for unit coal pulverizers had to be renewed about every two months. These were purchased from the pulverizer manufacturer at $20 apiece. It was found that a local foundry would make them for $10. To the superintendent this was a positive saving, and the local concern was given a contract for supplying these parts. The maintenance crew informs me that the liners now used last from two to three weeks only, showing a considerable increase in cost.

Failure to equip machines with necessary devices for safe operation is another example of an ultimate expenditure many times the original amount saved. One plant engineer believed that he could use ordinary double-pole knife switches on field circuits of several electrical machines. In the following two years, $150 had to be spent for repairs of field windings damaged by high-voltage caused by breaking the field circuits with these switches, and a change had to be made to the proper type of switches with field discharge resistors.

Employ Competent Labor

In conclusion I wish to emphasize the importance of employing competent labor in the power plant. Attempting to save a few hundred dollars a year by employing engineers who will work for the lowest pay is almost always poor policy. With improved power equipment and control and the application of up-to-date operating methods, it is essential that the plant be in the hands of intelligent men. These are not often the lowest priced, but in reduced operating expenses save more than their slightly higher salaries.

WER PLANT CRUSHERS AND PULVERIZERS

What Lubricant Should You Use?

As the monograph on the preceding page explains, an efficient lubricant for power plant crushers and pulverizers usually must perform two functions — reduce frictional resistance and wear — provide a seal against the entrance of dirt, fuel particles or water.

The Standard Oil Company (Indiana) has developed a complete line of lubricants of varying characteristics in order to adequately provide this dual protection for all types of crushing and pulverizing equipment under all conditions. When a Standard Oil Lubrication Engineer studies the requirements of any installation and determines what characteristics are required in a lubricant for the efficient discharge of its dual function, he is able to find among our complete line of crusher and pulverizer lubricants, one that has all the desired qualities.

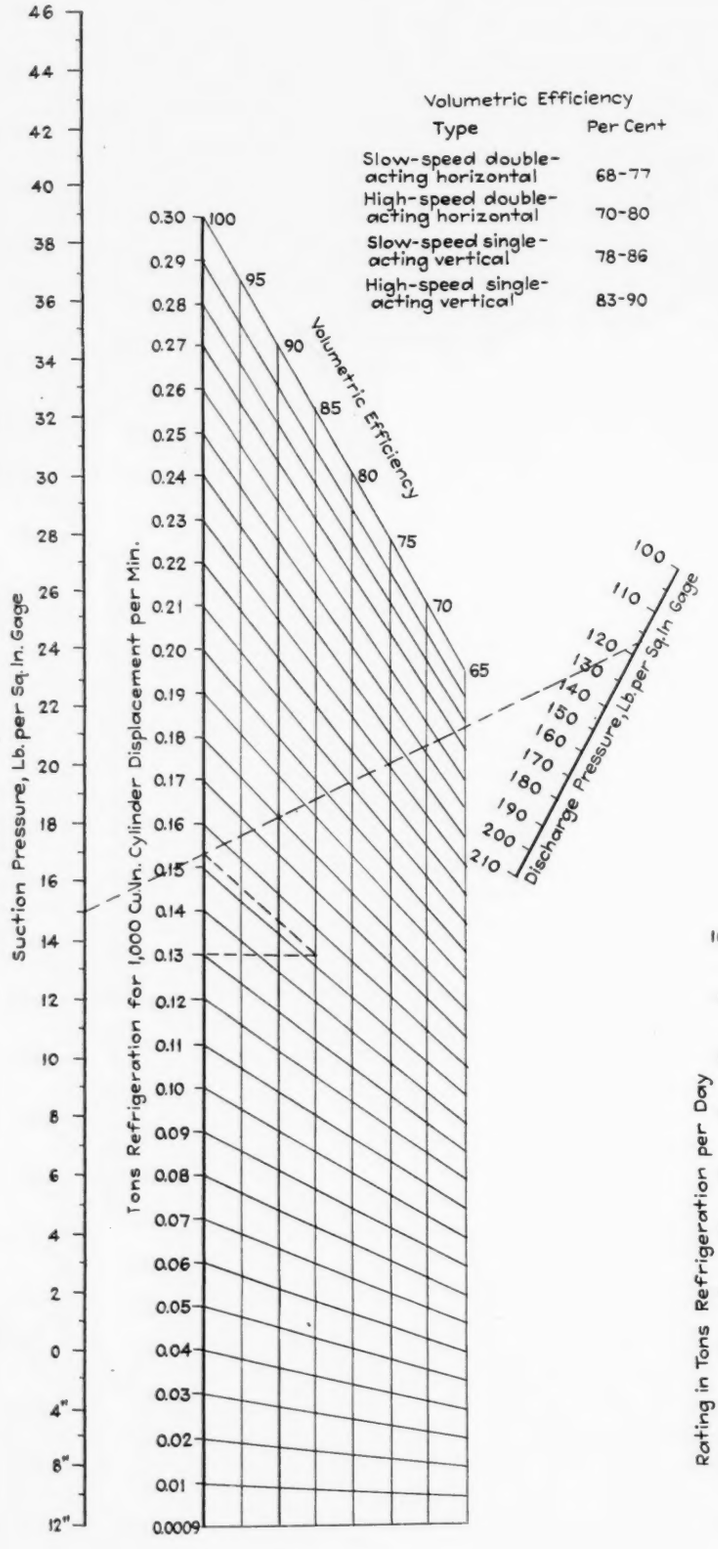
There need be no compromise.

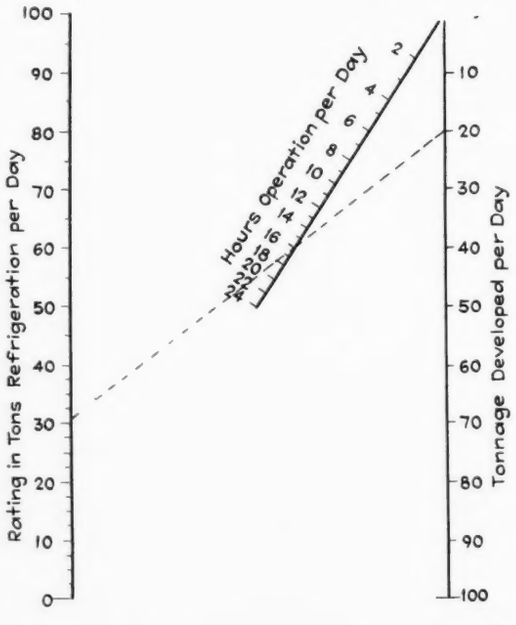
The Standard Oil Company (Indiana) has the facilities and the trained engineering personnel to render complete lubrication engineering service and to solve any specific lubrication problem. You'll find that it is profitable to turn your lubrication problems over to Standard Engineers. 1202

STANDARD OIL COMPANY (INDIANA) SERVICE

NRA U.S. WE DO OUR PART

Refrigeration Capacity of Ammonia Compressors


Volumetric Efficiency
Type | Per Cent
Slow-speed double-acting horizontal | 68-77
High-speed double-acting horizontal | 70-80
Slow-speed single-acting vertical | 78-86
High-speed single-acting vertical | 83-90
Suction Pressure, Lb. per Sq. In. Gage
Tons Refrigeration for 1,000 Cu. In. Cylinder Displacement per Min.
Volumetric Efficiency
Discharge Pressure, Lb. per Sq. In. Gage



● MANY PLANTS keep daily records of the refrigeration output of their ammonia compressors. This chart will eliminate most of the calculations usually necessary.

The left-hand chart is for an ammonia compressor having 1,000 cu.in. of piston displacement per minute. To find the refrigeration developed by a compressor of some other size, it is only necessary to multiply the tonnage obtainable from the chart by a constant determined from the formula:

$$C = (D^2 \times S \times N) \div 1273$$

in which D = diameter of cylinder in inches, S = stroke in inches, N = revolutions per minute and C the constant for a single-acting, single-cylinder compressor. For a double-acting compressor, multiply by two. For a multi-cylinder machine, multiply by the number of cylinders. The constant need only be determined once for the compressors in your plant.

Example—Find the developed tonnage for a 10x10-in., vertical, single-acting, 2-cyl. compressor operating for 16 hr. at 150 r.p.m. with 15-lb. suction, 125-lb. gage head pressure and 85 per cent volumetric efficiency.

The constant for this compressor is $(10 \times 10 \times 10 \times 150 \times 2) \div 1273 = 236$.

Entering the left-hand chart, connect 15-lb. suction pressure with 125-lb. discharge pressure and on the center scale read 0.154, the tonnage for a 1,000-cu.in. machine at 100 per cent volumetric efficiency. To find output for 85 per cent efficiency, parallel the diagonal lines from 0.154 to the 85 per cent line and then proceed horizontally to 0.13 on the center scale. The 24-hr. output of the compressor is then $0.13 \times 236 = 30.6$ tons. The output for 16 hr. of operation is found from the right-hand chart to be 20 tons.

© POWER

CRANKLESS OPPOSED-PISTON DIESEL ENGINE

New unit is much simplified. Diesels take prominent part in New York Motor Boat Show

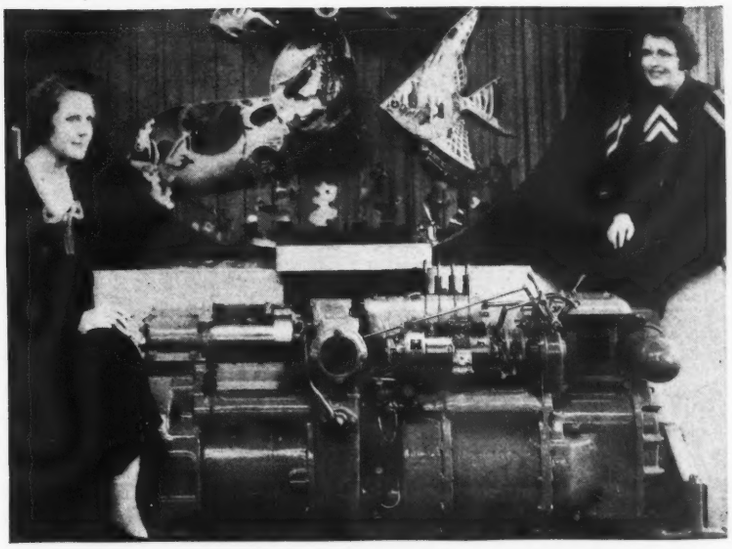


Fig. 1—120-hp. (constant-duty) crankless diesel

ELIMINATING crankshaft, connecting rods, cylinder heads, gaskets, valves and camshafts, the new high-speed, crankless, horizontal diesel of Sterling Engine Company, Buffalo, N. Y., may forecast a revolutionary trend in design. It weighs but 13-20 lb. per b.hp., depending upon size and service, as contrasted with the usual 40 to 50 lb. It is a 2-cycle unit, and fuel consumption is guaranteed to be 0.43 lb. per b.hp.

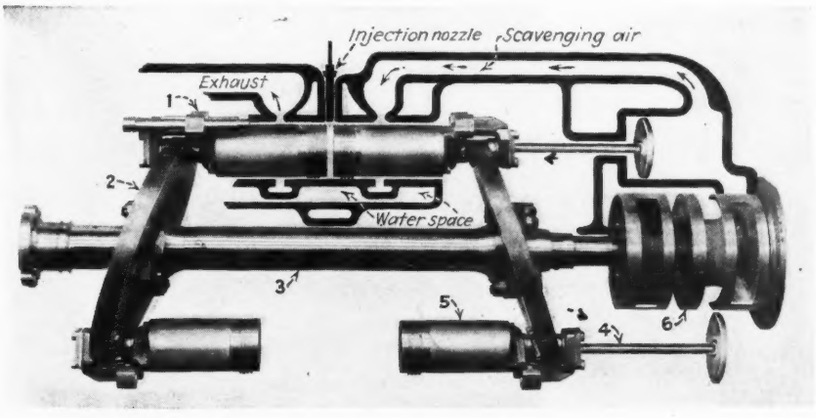
Built under license from A. G. M. Michell, who, simultaneously with Kingsbury, developed the Michell or Kingsbury thrust bearings almost universally used for ocean liners, the engine uses the angle disk plate principle which Mr. Michell used in his first diesel design described in *Power* several years ago. The engine has four horizontal cylinders, each containing two opposed reciprocating pistons. Thus, the engine is equivalent to the usual 2-cycle 8-cyl. engine of corresponding bore and stroke. The cylinders are arranged about a straight drive shaft which carries an inclined disk at each end. The disks are virtually flywheels.

The mechanical bearing units which transfer the power from pistons to drive shafts utilize the same principle as the Michell and Kingsbury thrust bearings, i.e., a bridge from the piston base of U shape passes over the rim of the disk and carries two bearing surfaces, the thrust surface being a slipper of rectangular shape with babbitt bearing surface, mounted on a half sphere, the other bearing (which serves only to position the piston) being a bronze-faced half sphere. This provides a universal mounting which permits the bridge to adapt itself to any motion of the inclined disk. The bridge is guided by two short rods extending through guide holes at the hump of the U.

The engine follows conventional 2-cycle design in that circumferential ports replace valves. Scavenging air is provided by a pressure pump. However, instead of the usual rotary or centrifugal blower, with its attendant gearing and possible hampering of flexibility in operation, this engine uses piston-type pumps, the piston being mounted directly on the end of the piston bridge.

Fig. 2—Principles of the mechanism

The diagrammatic portion shows arrangement of gas passages, etc. Parts numbered are: 1—bridge, 2—inclined disk, 3—straight shaft, 4—scavenging air pistons, 5—piston, 6—air distributing valve. Only additional moving parts are the gear train which drives lubricating, fuel and water pumps and the battery-charging generator.



Air is distributed by a simple rotary valve at the end of the shaft.

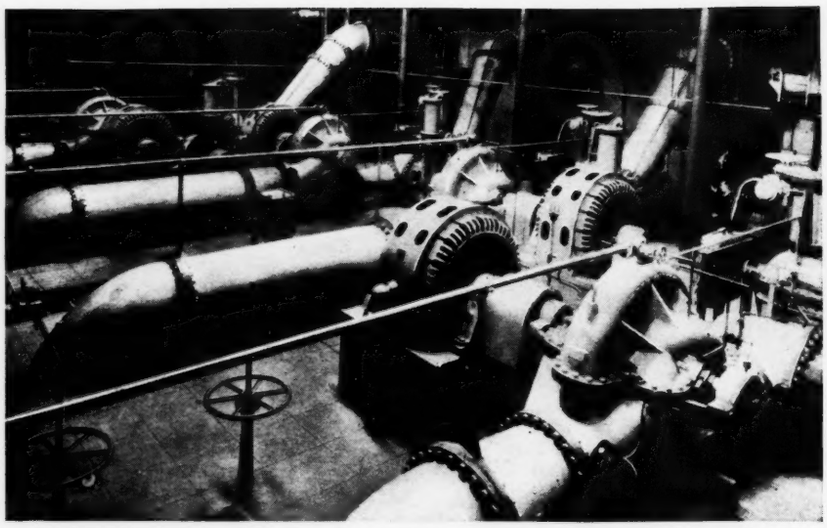
There are separate rows of intake and exhaust ports at opposite ends, and extending completely around, the cylinder. Thus one piston uncovers the exhaust ports, the other the intake ports. Exhaust ports are uncovered first. The charge of fresh air is given a spiral or swirling motion to clean out the combustion chamber and aid in obtaining more complete combustion. The air charge is compressed to about 500 lb., and at this point the fuel (28-32 Bé) is sprayed in, under a pressure of 1,500 to 2,000 lb. per sq.in. As the fuel leaves the nozzle, it is whirled and mixed thoroughly with the air and ignited by the heat of compression. Slightly concave piston surfaces prevent spray impingement on the piston crown. Air enters at one end of the cylinder and leaves at the other, providing uniflow charging and scavenging. Out-of-phase pistons provide a longer combustion interval, at approximately constant volume.

The high speed of the engine and the 2-stroke cycle combine to provide more uniform average cylinder temperatures and greater combustion flexibility and speed range. The heat economy resulting from proper combination of combustion space and port area, together with the absence of water-cooled cylinder heads, results in high cylinder capacity and excellent power output. Horizontal opposed movement of the pistons provides greater smoothness and the absence of a crankshaft avoids piston side thrust on the cylinder walls. This lessens piston and ring wear. Torsional vibration is also eliminated. When necessary, pistons may be removed without dismantling the engine.

Speed ranges from a minimum of 200 r.p.m. to a full-load operating speed of about 1,800 r.p.m. Vibration, because of the opposed-piston construction, is practically eliminated, as is direct structural loading of the frame. Exhaust temperatures are lower and torque characteristics are uniform. Instead of the

(Continued on page 111)

By CHARLES C. SHUTT
Industrial Power Engineer,
Westinghouse Elec. & Mfg. Co.



Four 1,250-hp., 4,400 volt synchronous motors drive centrifugal pumps in New York City's Ridgewood pumping station

NEW DESIGNS *EXTEND* SYNCHRONOUS MOTOR USES

Two new designs of high-speed synchronous motors, one for severe starting conditions, another for centrifugal-pump applications, take comparatively low starting current when started by connecting directly to the line

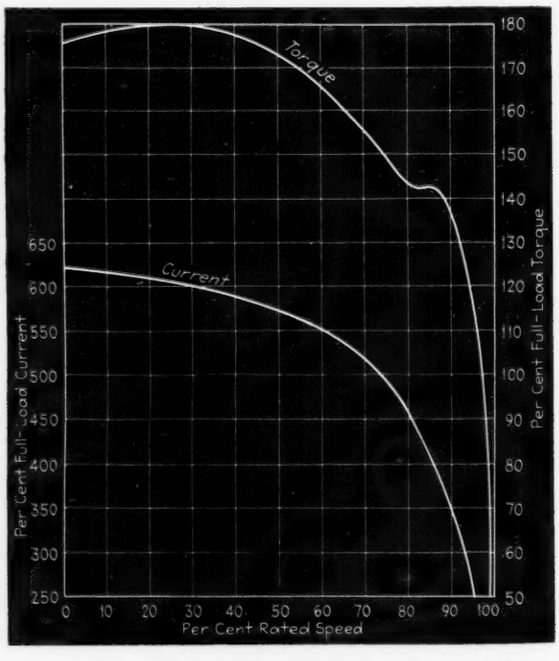
MOST industrial drives to which high-torque synchronous motors are applied operate at medium or low speeds. These include tube and ball mills and grinders in cement plants, beaters and grinders in paper mills and flour mills, and rolls in steel mills. In some cases it is found desirable to use high-speed motors with large speed reductions through some form of mechanical transmission.

In general, a four-, six- or eight-pole motor will develop sufficient torque to start and accelerate any of these drives under load when designed with a suitable damper winding and in a frame which is little or no larger than standard. Due to the inherent characteristics of high-speed synchronous motors and improvements in design, such motors can be started on full voltage with simple control equipment and will take only a moderate amount of starting current. The torque and current of a standard high-torque synchronous motor are plotted against speed through the starting period in Fig. 1.

This motor develops 175 per cent starting torque and 115 per cent pull-in torque and takes 625 per cent of full-load current at start. The 625 per cent starting current is based on a motor rated at 100 per cent power factor. If the motor is designed for 80 per cent power factor, the per cent starting current is 500. Such motors can be designed with higher or lower torques with corresponding changes in the starting current.

There are, however, many installations where these torques must be developed with lower starting current, due to power company regulations or limited generator or line capacity. For such cases special motors are required. A number of special types of synchronous motors have been developed for high-torque drives which have quite low starting current. But these developments are limited largely to low-speed designs.

Fig. 1—Speed-torque and current curves for a standard high-speed, high-torque synchronous motor



A type of high-speed synchronous motor which previously has been used but little, if any, in this country, has been developed. This will provide ample torque for any drive and yet keep the starting current to a comparatively low value. In addition, this motor gives the operator the same control over acceleration as he has over conventional wound-rotor induction motors. This new motor has standard stator and field windings as does the ordinary type. By special design of the poles, the squirrel-cage damper winding is replaced by one similar to that used on the rotor of a wound-rotor induction motor. This damper winding is connected in three phases and brought out to three slip rings. Unlike the induction motor, the slip rings carry current only during the starting period, thus are kept polished by the action of brushes. These rings are in addition to those for excitation current to the field winding during normal running.

Fig. 2 is an elementary control diagram for this motor. When breaker No. 1 closes, it connects the stator winding to the line. As the motor comes up to speed, contactors *A, B* and *C* are closed successively to cut resistance out of the damper-winding circuit. After the motor has attained near synchronous speed, contactor No. 2 applies the excitation voltage to the field winding and disconnects the field-circuit starting resistance.

This new high-speed motor combines the starting characteristics of a wound-rotor induction motor with the operating advantages of a synchronous motor. Synchronous motors with cylindrical rotors and only a single winding of the induction-motor type have been used, both in this country and abroad. The single rotor winding is used as damper winding during start-

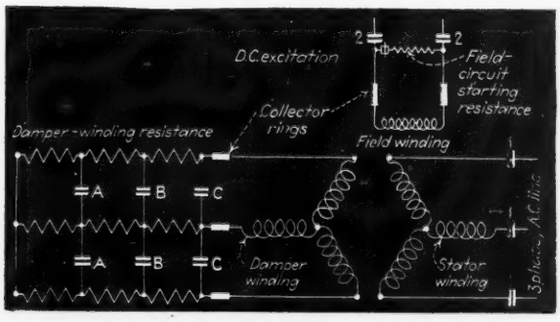


Fig. 2—Elementary control diagram of new high-speed, high-torque synchronous motor

ing and as field winding at synchronous speed. This type is sometimes called the synchronous-induction motor. While it has a better starting performance than the new motor with salient poles and two windings on the rotor, its operation at synchronous speed is not so good.

The tested starting performance on a 150-hp., 900-r.p.m. motor of the new type is shown in Fig. 3. The changes in torque and current can be made less abrupt by using more contactors in the damper-winding resistance circuit to increase the number of steps. The step at the extreme left, the first point on the control, is to take up the slack in the belts and is not expected to start the load. The currents are expressed in per cent of full-load current at 100 per cent power factor.

A centrifugal pump is an important application

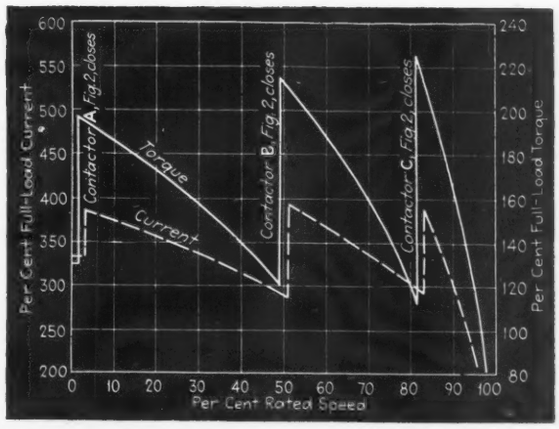


Fig. 3—Speed-torque and current curves of new high-speed, high-torque synchronous motor

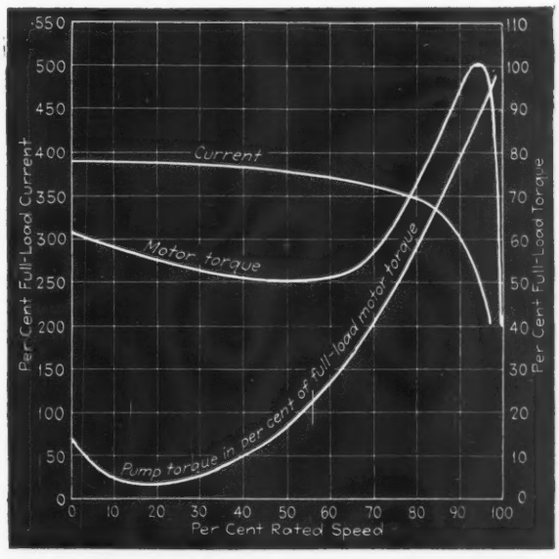
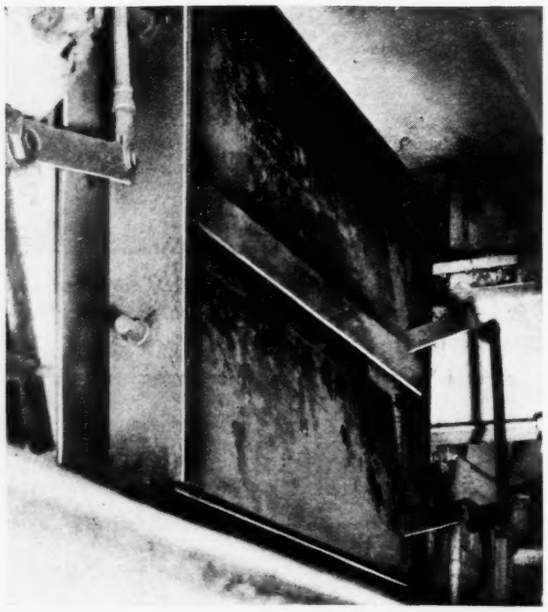

Per Cent Full-Load Current
Per Cent Full-Load Torque
Per Cent Rated Speed
Current
Motor torque
Pump torque in per cent of full-load motor torque

Fig. 4—Speed-torque and current curves of high-speed synchronous motor for pump drive

where high-speed motors are directly coupled to the load. Here the starting torque need not be high, but at least 100 per cent pull-in torque is required because of the rising-torque characteristic of the pump as it comes up to speed with the valves open. Formerly, such installations used a standard synchronous motor with an auto-transformer or a reactor to reduce the current during the initial part of the starting period. But the recent trend is to eliminate the transformer or reactor and to use motors of the full-voltage starting type specially designed to keep down the starting current.

A recently developed high-speed motor for pump drive produces high pull-in torque with low starting current. It has a normal stator winding and requires only standard full-voltage control equipment. This is accomplished by means of a special, yet simple, design of the squirrel-cage damper winding. The speed-torque and speed-current curves of this motor are shown in Fig. 4. Because of its characteristics, this motor is also suitable for centrifugal blowers or similar loads where the starting current must be kept low without bulky and expensive auxiliary equipment.

PRACTICAL AIDS TO OPERATION



Stack Base Damper Improves Combustion Control

IN THE St. George Hotel, Brooklyn, the boiler plant has four boilers, and the stack has been designed to operate these boilers at 200 per cent rating. Two boilers have so far been sufficient to carry the load. When operating under this condition, the stack has considerable reserve capacity. To make use of this and at the same time to improve ventilation in the boiler room, a damper, shown in the figure, was installed in the stack base.

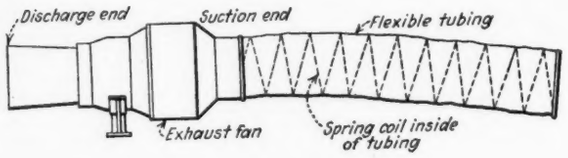
This damper is operated automatically by a regulator which causes it to close as the boiler uptake dampers open, and open when the uptake dampers move toward closed position. The stack damper is connected so that at no time is it completely closed. Operation of this damper keeps the flow of air from the boiler room fairly constant, with consequent improvement in ventilation. The stack-damper also lessens uptake-damper travel necessary if all combustion regulation were done by them. This feature allows closer control of combustion and a more constant draft on the fire than is possible with uptake dampers alone. To reduce the distance through which the dampers must travel to provide a given change in air flow, those in the boiler uptake and in the stack base are made in two sections. These dampers, if made in one piece, would be of quite large dimensions and not as well adapted to automatic control as when made in two sections.

Brooklyn, N. Y. JOHN A. SETHER
Chief Engineer
St. George Hotel.

Reinforcing Flexible Tubing

FLEXIBLE TUBING is frequently used to connect blower discharges to a pipe line, especially for temporary installations or to avoid the expense of complicated pipe fitting. No trouble is experienced due to collapsing of the tubing, since discharge pressure tends to keep it open. When flexible tubing is used on the suction side of an exhaust fan, however, the pressure within the tubing is lower than it is outside, and unless the tubing is reinforced it will collapse. I have found this method of reinforcing satisfactory.

A coil made from $\frac{1}{8}$-in. spring wire and inserted in



the tubing with the coils spaced about $2\frac{1}{2}$ in. apart, as in the figure, does the trick. The spring should be wound on a sufficiently small arbor so that when it is removed from the arbor it will expand to the approximate diameter of the tubing. In order to keep the coils about the same distance apart, every third coil should be tacked to the tubing with carpet thread. One should not be surprised at the length of wire required. For example, in a 10-ft. length of 8-in. tubing with coils spaced $2\frac{1}{2}$ in. apart, 120 ft. of wire is necessary.

Worcester, Mass. DAVID FLIEGELMAN.

Tubular Shafting Avoids Deflection In Long, Unsupported Sections

WHEN it becomes necessary to transmit power by shafting over a space where supporting bearings cannot be spaced closely enough to avoid excessive deflection, a tube may be used. A case in point is where it was desirable to transmit power across a wide alley between plant buildings. It is possible to provide a trussed shaft in places of this kind, but often a suitable tube-shaft is all that is required. A tube will deliver far greater torque in proportion to its weight than will a solid shaft and is always well worth considering before going to the expense of a trussed-shaft installation.

Peoria, Ill. JOHN E. HYLER.

Installing Soot Blowers

ALTHOUGH soot blowers installed in the first pass of a boiler will not entirely eliminate hand lancing for removing slag from tubes directly exposed to the fire, their use in this location has grown greatly in recent years and has proved fundamentally sound. Due to the development of heat-resisting alloys, soot-blower elements are available that will successfully withstand temperatures encountered in the first pass, except under abnormal conditions. In horizontal cross-drum boilers, one or two units installed at the top of the first pass, and one unit between the first row of tubes as close as possible to the boiler headers, will be found in most cases to give satisfactory service and will cut the necessity of hand lancing to a minimum.

Steam is somewhat more effective for removing slag than compressed air. This is because the steam is usually at higher pressure than air, also because steam attains a higher velocity than air when expanding from the same pressure. Maintenance costs are in general higher on steam-operated units, due to leaks in the piping, packing glands, valves and swivel tubes; troubles that do not develop when compressed air is used.

When installing soot blowers, care should be taken that the nozzle spacing corresponds with the tube spacing, and that the valves are properly timed. In maintaining soot blowers, special care should be taken to guard against sticking valves that may allow steam or air to enter the element after the blowing arc has been completed.

For removing dust and fly ash from the second or last pass of the boiler, gas reheaters, economizer or air preheater, compressed air is as effective as steam and has the advantage of extremely low maintenance cost. Elements in these positions will last almost indefinitely, and swivel-tube wear is practically negligible if proper packing is used.

One of the principal causes of element failure is the sudden temperature change that takes place at the time the unit is blown. This sets up severe temperature stresses because the inner surface of the tube wall is cooled suddenly when the valve is opened, while the outer surface remains at a high temperature. Temperature equalization scarcely has time to take place before the blowing period is over, and excessive creep, grain growth and embrittlement is caused. It is also a cause of warping, especially when one side of the element is somewhat exposed to radiant heat.

The cooling effect of expanding air is also a cause of trouble. The outer edge of the flared nozzle is cooled to a comparatively low temperature, and the nozzle, as a conductor of heat, also cools the tube wall directly around it. This rapid cooling and shrinking actually causes cracking of this highly stressed area, and after a crack is started it will generally open far enough in a short time to allow the nozzle to blow out. Such cracks, if found in time, can be filled and the nozzle welded in place.

Examination of element failures invariably reveals warping is more severe near the inlet end, and nozzle failures starting at the inlet gradually disappear, seldom, if ever, extending more than two-thirds of the length of the element. Nozzles near the dead end are nearly always found to be in good condition.

By using preheated air, temperature stresses can undoubtedly be reduced. To be effective, the air must be heated to a fairly high temperature, which could be accomplished by placing air heating coils in the gas passage, probably adjacent to the economizer. Additional advantages would be a considerable saving in compressor power and an increase in capacity.

South Amboy, N. J. RAYMOND SEPTOR.

Slip-Ring Treatment Against Chlorine Gas

A PHASE-WOUND motor gave trouble due to heating and flat spots on the slip rings. After considerable investigation, the cause was traced to a slight amount of chlorine in the atmosphere. The chlorine, from one of the processes, caused a thin film of copper chloride, which has a comparatively high resistance, to form on the surface of the rings.

The flat spots were caused from the film not being uniform around the rings, because parts of the rings would be covered continuously by the brushes when the machine was idle. As a result, when the machine was again started, the parts of the rings which had been exposed during shutdown would have a higher resistance than the sections covered by the brushes.

As the motor could not be properly protected from the chlorine fumes, brushes were installed that were slightly abrasive, to clean the surface of the rings. To protect the rings against the action of the fumes when the motor was idle, a piece of paraffin wax was applied to the rings shortly before stopping. This formed a protective film over the surface of the rings against the chlorine.

Welwyn, England W. E. WARNER

Installing and Removing Piston Rings

THE FIGURES show methods I have used to put piston rings into their grooves and also to remove them. For placing piston rings, a sheet steel form is made that is part frustrum of a cone and part cylindrical, as in Fig. 1. The cylindrical section is made of a diameter to fit tightly around the piston. It is made open on one side and when in place has a 2- or 3-in. gap.

To put in the rings, the cylindrical section of the form is pushed over the piston to the near edge of the farthest groove and prevented from going any farther by small wood blocks placed in the groove. The ring is then

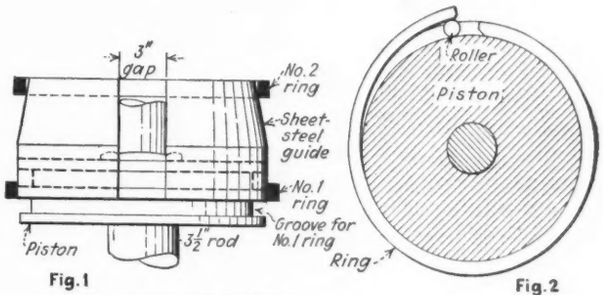
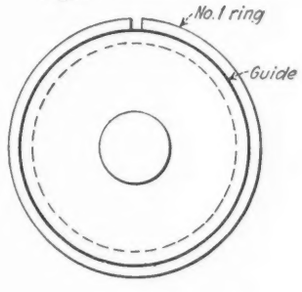
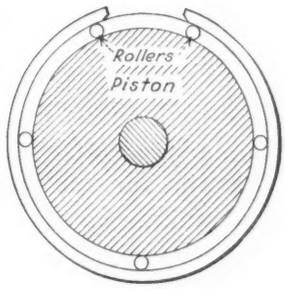


Fig. 1

Fig. 2





placed on the tapered section and slid up to the far end of the cylindrical section. After removing the wood blocks the ring is dropped into the groove. The form is then moved back to the next groove, is blocked into place and the next ring put into place.

To remove the rings, all that is required is five rollers cut from a bright steel bar of a diameter slightly greater than the depth of the groove and of a length slightly less than the width of the groove. One end of the ring is raised and a roller inserted under it. The ring is then rotated so that the roller will roll under it. Addi-

tional rolls are fed in so that they will be approximately equally spaced around the ring. The sheet-steel guide used to place the ring may now be used to slide it out over the piston.

London, England. J. T. TOWLSON

Cracks in Return Tubular Boiler Repaired by Welding

IT IS QUITE COMMON for return-tubular boilers, after many years of service, to develop fire cracks in the girth seams. The sheet cracks from the rivet hole to the edge of the plate. When we had trouble with these cracks in our boilers, we tried to weld them by both electric and acetylene welding.

The remedy recommended by an insurance company was to cut out all rivets in the girth seam, cut off about 6 in. of the sheet, drill new rivet holes and rerivet the seam, making the boiler about 6 in. shorter. This plan, while being quite expensive, also required cutting the tubes and rolling them into the flue sheet. This plan was not new with the insurance company and had been done successfully.

However, we decided to try once more to repair the cracks by acetylene welding, as it seemed to be most successful. It was the conclusion that if the stress in the welds could be relieved, they would not crack.

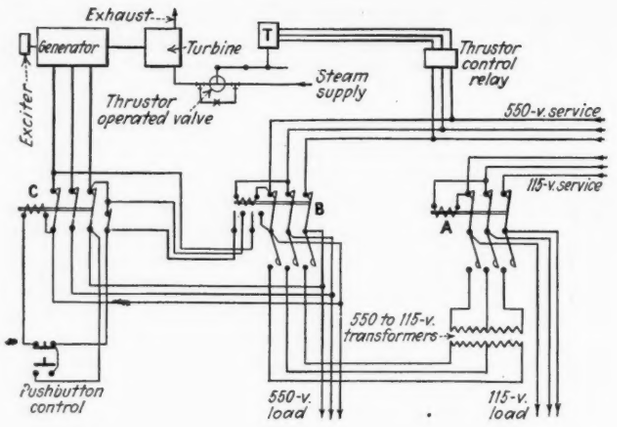
In one of the boilers, we cut out twelve rivets where there were nine fine cracks. The old metal at the cracks was cut out to about $\frac{1}{2}$ in. wide to get to good stock. When they were rewelded, a piece of carbon from an old dry cell was inserted in the rivet hole to keep the weld from flowing into the hole. The carbon was slightly smaller than the hole but was wedged in to hold it in place. After the weld was made, a long tapered punch was driven into the hole to expand it to full size. It was assumed that this operation would relieve the stresses in the welds which had caused the previous failure. After all cracks were welded and the rivet holes expanded, a portable electric grinder was used to smooth off the plate. One-inch cap screws were then put into the rivet holes and the nuts drawn as tightly as possible with a 2-ft. wrench. One bolt was taken out at a time and new rivets driven. It has been several months since this was done to three boilers. To date there is no leak.

Libby, Mont. FRANK E. BATEMAN.

Steam Standby Generating Set Operates Automatically

THE AUTOMATIC CONTROL shown in the diagram was developed for a hospital installation where electric service for operating rooms, emergency lighting and power equipment, such as elevators, and pumps, was essential at all times. In this case a turbine-generator set was selected because boiler capacity was always available, and it was desired to operate the generator as a synchronous condenser at certain times for power-factor and correction. Normal power supply is obtained at 115 to 230 volts for lighting and 550 volts for power.

On failure of normal service, the Thrustor-operated main valve admits steam to the turbine. Transfer switches *A* and *B* throw the load on the generator, but the generator contactor does not close until exciter voltage has built up and field is applied to the generator. The



set then takes load, voltage being maintained by a simple regulator. When on the generator, the lighting is supplied from two distribution transformers, connected open-delta.

On return of normal supply, the load is transferred, steam is cut off, and the generator runs as a condenser. Manual pushbutton control permits the condenser to be shut down or started at any time. On power failure, the manual control is shunted out by auxiliary contacts on the *B* transfer switch. The generator is provided with standard automatic starting control (not shown) and will automatically start up and take load if shut down at the time of power failure. The set must be shut down by the operator after normal service has been resumed.

The generator is a standard revolving-field type, equipped with an amortisseur winding. The turbine is a single-stage non-condensing type designed for quick starting, and exhausts a 5 lb. back pressure. Exhaust is connected to an exhaust header to maintain heat in the turbine for quick starting. The dashpot action of the Thrustor-operated valve prevents the sudden application of full pressure to the turbine.

Montreal, Canada R. G. BARBOUR,
McDougall & Friedman,
Consulting Engineers

Gas Leaks Into Boiler, Causes an Explosion

A BOILER used for supplying steam to a gas generator was emptied to permit the renewal of a fusible plug. The stop valve between the boiler and the generator was closed, a manhole cover was removed and a man attempted to enter with a lighted candle. An explosion resulted that burned him but fortunately no serious damage was done. The stop valve between the boiler and the generator had been leaking, and when the water was emptied from the boiler, gas entered it.

It is important that stop valves used in these positions be kept steam and gas tight. As an additional precaution the gas generator should have been disconnected from the boiler at a convenient place *before* the boiler was emptied. In this case, no serious damage was done, but had the man been in the boiler when the explosion occurred, the results might have been disastrous. If an electric hand lamp had been used for illumination, the man might have entered the boiler and been asphyxiated.

Brooklyn, N. Y. S. H. ASHTON.

CURRENT COMMENT

What Causes A Centrifugal Pump To Lose Its Prime?

WHY DOES a centrifugal pump lose its prime? This question and the answers afford a variety of conjectures. Unless the water is hot, a centrifugal pump only loses its priming by getting air-bound.

When the prime is lost, test as follows:

First see that the foot valve is tight. Then take it off and put a cap on the end of the suction. Let the water under pressure come back into the suction, or connect the pipe with a water or compressed air line. Go over each joint in the suction and examine for leaks.

If compressed air is available for testing for leaks, paint each joint with soap suds and watch for bubbles. If water is used, add a little ammonia to the water and test any suspicious places with phenolphthalein paper (which can be had at any refrigerating plant or dealer in ammonia or refrigerating supplies). If leaks are located, calk them with candle wicking soaked with white or red lead in oil. Should this fail, look at the stuffing box when the pump is operating at full speed. Make sure there are no leaks through the packing.

Automatic priming equipment can be installed on the pump, but I have found a simpler device very satisfactory. Remove the pet-cock at the highest point on the pump casing, insert a short nipple, and connect a vertical check valve *upside down*. In this, insert another nipple and an ejector, connecting the smaller opening to a water or air line under pressure. On opening the valve leading to the ejector, any air or vapor is sucked out of the pump, but when the water follows it, the vertical check is lifted and the device becomes inoperative. A large pump creates more or less turbulence around the entrance to the foot valve, and air may be drawn down through a foot or more of water. The remedy is to make the suction deeper.

St. Louis. L. R. BAKER.

Flywheel Failure Causes Mystery

A MYSTERY resulted from an exploding flywheel in Albuquerque, N. M., last November. A circular cordwood saw with a 6-in. pulley was belted to the 30-in. back wheel of an automobile, placed on blocks. The engine was operated at nearly full throttle when the saw was used, and was allowed to race between cuts. During one of these periods, the speed of the saw became so high that its flywheel exploded. One section of the rim about 8 in. long was thrown about ½ mi. and crashed through the roof of a floral shop, fortunately without injuring anyone.

For several days it was a mystery where this fragment came from. It was generally believed that the fragment fell from an aeroplane, flying so high as not to be observed. The local police found a man who had heard something whizzing through the air several blocks south of the damaged building about the time the accident happened. Further investigation disclosed the disabled saw, and the owner of the saw paid for the damage to the floral shop.

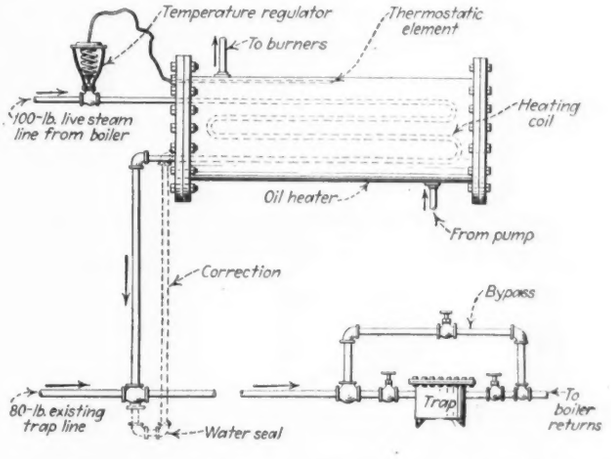
This accident calls to mind numerous other flywheel accidents that have occurred in industrial plants. There is a real danger if these wheels are allowed to overspeed. The stress in the rim of a flywheel varies as the square of the velocity. As the speed is increased, the bursting point is approached more rapidly than ordinary judgment might indicate. Most of the serious flywheel accidents are caused by large-diameter wheels on steam engines, but the incident cited shows that small wheels also may cause considerable damage to life and property.

Albuquerque, N. M. H. G. SMITH.

Don't Return Condensation From Oil Heaters to Boilers

IN THE LETTER, "Steam Backs Up Into Heater and Causes High Temperature," by M. E. Wagner in the December number, I agree with his first sentence, which read: "Where high-pressure trap systems are installed, it is important that each individual condensate drain have its own trap." To this, I would add, "and discharge into a vented receiver or hot well."

The illustration is that used in Mr. Wagner's article and shows a steam-tube oil heater. Presumably there is a large pressure reduction in the steam coils, for the steam will condense rapidly under conditions of heavy



oil draft. Manufacturers of modern fuel-oil heaters universally design their equipment with steam in shell and oil in tubes.

Considering the pressure drop in the steam unit of the heater, the terminal pressure at outlet may be anything from 100 lb. to zero. The terminal pressure with the temperature regulator closed would presumably be zero. In this case, with 80 lb. in the trap line, the riser from water seal to condensate outlet of the oil heater should be of sufficient height to balance this pressure (about 180 ft.). Without a riser of sufficient height to carry a weight of water to balance, the pressure existing in the trap line to which the condensate from

the oil heater flows, a seal is of little or no value.

A heater for any purpose is subject to shocks, misuse and wear and tear. A steam-tube heater is liable to hammer where high-pressure steam and condensate conflict, so a steam-tube heater, particularly with long flow length, is more likely to have ruptures in tubes than an oil-tube heater. In case leakage of oil into steam or condensate space occurs when the condensation is returned to the boilers, the result may be ruined boilers. This leads us to a primary principle—"Don't return condensation from oil heaters to boilers."

Boston, Mass. WM. WILCOX.

Free-Piston Diesel-Compressor

THE PESCARA diesel-compressor, described in *Power* in November, 1932 (page 237), has been further developed by the Swiss Locomotive & Machine Co., Winterthur, Switzerland. Last month, this company finished construction and made a continuous trial run of ten days with a 250-i.hp. free-piston two-stage diesel-compressor burning gas-oil and furnishing air at 210 lb. pressure.

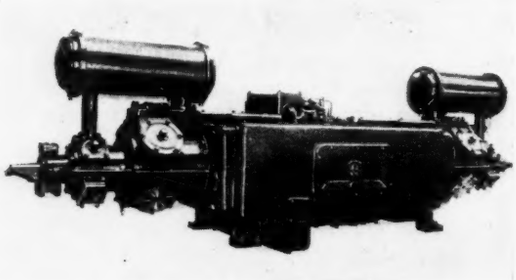


Fig. 1—250-hp. free-piston diesel-compressoor

This unit, illustrated in Fig. 1, is water cooled, but air cooling can be used if preferred. The machine weighs approximately 5,000 lb., runs at 1,300 strokes (650 explosions) per min.

Maison Breguet, 19 Rue Didot, Paris, France, has constructed 250 machines of the 20-hp. type shown in

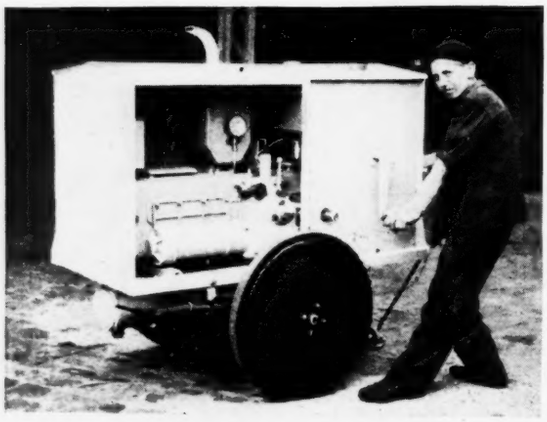


Fig. 2—20-hp. free-piston diesel-compressor

Fig. 2. These operate at 2,200 strokes (1,100 explosions) per min. Another machine builder in France is constructing a diesel-compressor air turbo-generator of 3,000 kw. capacity for one of the utility companies serving the City of Paris. Because of the equalizing action of the twin pistons, the machines operate without appreciable vibration, thus require no foundation. They are also extremely quiet in operation.

New York, N. Y. J. GOULD COUTANT.

What Price a Bucket of Oil?

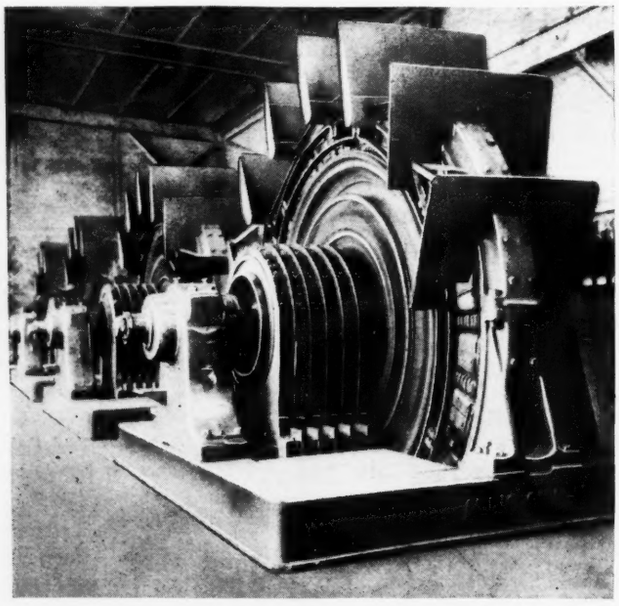
AN INTERESTING and somewhat amusing example of false economy occurred in a plant recently. The boilers operate at high pressure and have an automatic combustion-control system that uses oil-pressure cylinders and plungers as the actuating force. The positions of the plungers in their cylinders are controlled by pilot valves in the pressure line from the oil pump. From either neglect or the belief that only clean oil would ever be used, no oil strainers were installed in this system.

It happened that the oil level in the pump-suction reservoir was getting low. An engineer decided to save the cost of new oil and poured in a bucket of old oil that contained sludge and water. As a result, all pilot valves stuck and the entire system had to be flushed out. To this expense must be added the cost of several hours' erratic operation without automatic regulation—all for the price of a bucket of oil.

Milford, N. J. HARRY M. SPRING, JR.

Ventilating System for Large Rotary Converters

FOUR 3,250-kw., 250-volt, 13,000-amp. rotary converters in one of the substations of the Westvaco Chlorine Products, Inc., at S. Charlestown, W. Va., have an



interesting ventilating system. The vanes distributed around the field frame in the photo are to assist in directing the ventilating air toward the exhaust fans in the monitor. A fresh-air supply is led into the pits under the machine from a duct extending below all four machines. The vanes are all of the same construction, varying only as to the angle at which they are mounted. They are formed from heavy-gage sheet metal, U-shaped in section, with the sides acting as triangular stiffeners.

CENTRIFUGAL COMPRESSOR FOR

WATER-VAPOR REFRIGERATION

By PAUL A. BANCEL*
Ingersoll-Rand Co.

WATER-VAPOR refrigeration, now being used for air conditioning, has depended upon the steam jet for compressing the vapor from the very low pressures in the evaporator up to normal condenser pressures of about 28 in. vacuum. A centrifugal compressor has been developed to take the place of the steam jets. With it, the heat discharged to the condenser is only the refrigerating load plus the work of compression, as with the ordinary refrigerating cycle.

An enormous volume of highly attenuated water vapor must be compressed to condensing pressures compatible with cooling water supplies. Although these pressures are low, the ratio of compression is surprisingly high, being 4½ to 6 with a suction pressure of say 0.36 in. Hg.

In terms of a compressor working at atmospheric pressure, these ratios are equivalent to a discharge pressure of 50 to 75 lb. A compressor for 100 tons refrigeration would need to have a capacity of about 35,000 c.f.m. A machine built to operate with atmospheric air, discharging at 50 to 75 lb. pressure would require 5,000 to 7,000 hp. to drive it. Such a machine obviously would be unsuited for compressing 35,000 c.f.m. of low-pressure vapor requiring less than 100 hp.

Centrifugal units up to 300 tons capacity have been developed. They operate at speeds of 7,000 to 10,000 c.f.m. and may be driven either by motor or high-speed turbine. Fig. 2 shows a cross-section of compressor, evaporator and condenser built as a unit.

Water to be cooled is sprayed into the vaporizing chamber which is connected directly to the suction of the compressor. The compressor discharges to the condenser, which is in back and not shown in the illustration.

The centrifugal water-vapor unit differs from all other types in its part-load characteristics. In general, it is operated at constant speed. Under this condition and without other adjustments reduced tonnage is automatically reflected in reduced power input approximately in proportion to the tonnage. The unit simply floats on the line.

Fig. 1 shows typical volume characteristic curves. As the volume of vapor decreases, the ratio of compression increases, and over the design range the efficiency curve is flat. Power input is shown by curve P; at part volumes the brake horsepower decreases, but not proportionately. Curve P_1 shows the power for vapor of lower density. Within limits, a decrease in density at fixed volume results in an equivalent reduction in power. With a decreasing load, changes occur in both volume and density, which, for simplicity, can be considered as two distinct steps. First, a decrease in volume proportional to a decrease in refrigerating load as from A to B, Fig. 1. The power then decreases along curve P from A to B. Second, a decrease in density which increases the total volume to intermediate volume C. But due to the lower density, the power is now determined by Curve P_1 and the power at C is lower than at B.

Decreased density at reduced load is the result of reduced suction pressure, which in turn is due to the greater ratio of compression that the compressor can generate. Secondly, in most cases the condenser pressure decreases with reduced load, this further reduces the compressor suction pressure and vapor density.

With steam jets, only a small increase in chilled-water temperature occurs at overloads. A similar characteristic is true of the centrifugal unit. At constant intake volume, the weight of vapor compressed will increase with temperature. Actually the tendency, with constant condensing water conditions, is for the volume compressed to increase, because the higher suction pressure tends to reduce the ratio of compression demanded. The increase in capacity for a 5 deg. increase in chilled-water temperature is nearly 25 per cent.

This is to be contrasted with the sharp increase in chilled-water temperature in the case of machines using refrigerants. A small overload may readily increase the chilled-water temperature 10 deg. Two fundamental differences account for this. The change in density with increased temperature is more rapid with water vapor than any common refrigerant. Thus, for a given increase in temperature, the weight compressed by a constant volume compressor increases most with water vapor.

The heat of the chilled water must be transferred through tubular surfaces, and any increase in load must be reflected in an increased temperature difference, that is, the water must be hotter relative to the evaporating refrigerant to increase the heat-transfer rate.

Theoretical power consumptions for adiabatic compression of water vapor from 50 to 86 deg. and from 50 to 95 deg. are given in comparison with similar figures for ammonia, but with 35-deg. suction temperature. The lower suction temperature is used for ammonia, because of the temperature drop necessary to cool the water.

	Saturated Suction Temp., Deg.	Discharge Temperature, Deg.	Adiabatic Hp. per Ton
Water Vapor	50	86	0.371
" "	50	95	0.476
Ammonia	35	86	0.548
"	35	95	0.658

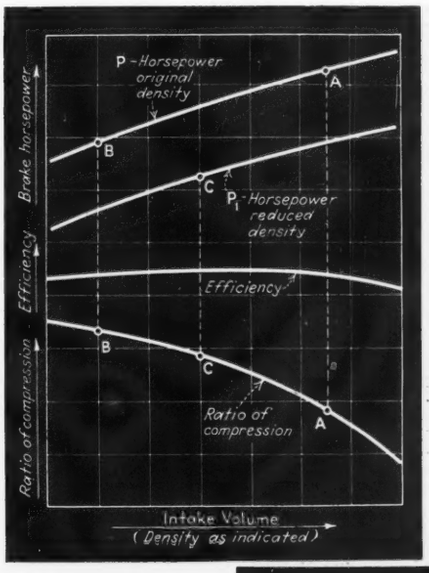


Fig. 1—Curves showing performance characteristics of a centrifugal water-vapor compressor

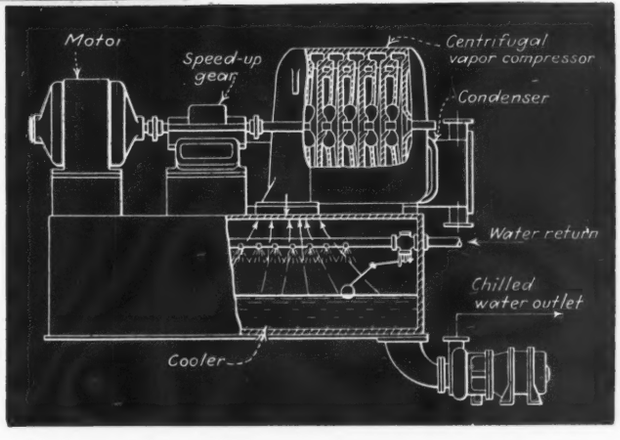


Fig. 2 (Right)—Centrifugal water-vapor refrigerating unit

*Abstract of a paper presented at the December, 1933, meeting of the American Institute of Chemical Engineers, in which the author also discussed steam-jet refrigeration.

SYMPOSIUM PRESENTS PROGRESS IN

LARGE POWER SWITCHING

Switching and bus design used in five large steam plants, ranging in size up to 700,000 kw. installed, and built since 1922, include the principal types of switching functions in most common use today on large systems, and the experiences with them

A SYMPOSIUM on switching at large modern generating stations was a feature for power engineers at the winter convention of the American Institute of Electrical Engineers, at the Engineering Societies Building, N. Y., Jan. 27-28. It comprised papers on five outstanding plants and a summary of the papers by Alfred H. Lovell. Switching-plant designs treated cover the period from 1922 to 1932: Hudson Avenue plant, Brooklyn Edison Co., 1922; Richmond Station, Philadelphia Electric Co., 1925; Long Beach No. 3 plant, Southern California Edison Co., 1928; State Line plant, Chicago District Electric Generating Corp., 1928; and Essex plant adjacent to Connors Creek plant, Detroit Edison Co.

Capacity of Stations

Capacities of these stations are: Hudson Avenue, planned for 400,000 kw., 770,000 kw. installed; Richmond, 120,000 kw. installed, and in 1935, 285,000 kw.; Long Beach No. 3, now 200,000 kw., ultimate, 800,000 kw.; State Line, including units under construction, 350,000 kw., ultimately, 1,000,000 to 1,500,000 kw.; and Essex, including units now under construction, 330,000 kw. installed, ultimate 450,000 kw.

A wide range of voltages for generation and transmission is represented in this group of stations, the particular value in each case being associated with special functions of the individual plant. At Hudson Avenue, bus and feeder-voltage is 27.6 kv.; Richmond, 13.8 kv. for feeders and frequency converters, 66-kv. to transmit bulk power; Long Beach No. 3, 16.5 kv. paralleled on 220-kv. bus, 66-kv. substations; State Line, 22-kv., 33-kv., 66-kv., and 132-kv. feeders; and Essex, 24-kv. bus and feeders.

These five stations represent principal types of switching functions in most common use on large systems. Each design, of course, has the fundamental problem of generator control; in addition, the various duties are:

Hudson Avenue—System supply, frequency conversion, and interconnection. Richmond—Feeders for system and railway supply, system ties, and interconnection with other systems. Long Beach—System supply and interconnection. State Line—Wholesale supply and interconnection center. Essex—Feeder supply to system, substation and system ties.

Busbar Arrangements

Many varieties of bus arrangements are represented, such as the vertical isolated phase, star design, double-bus sectionalized with reactors, H-connection, two duplicate rings, and a simple single bus with a single circuit breaker for each individual feeder.

Both indoor and outdoor buses are represented. In the former class, two use air insulation, while one uses Herkolite or Micarta insulation on copper tubing. One outdoor installation uses rigid hollow copper conductors with solid insulation of Micarta tubes in oil-filled pipes or inclosures, the other outdoor construction is 220 kv. air insulated. Some designers indicate their approval of the elimination of air as insulation for buses, yet find that other insulating materials present many problems. Furthermore, while some adopt oil as a bus-insulating medium, all are desirous of keeping to a minimum, oil that might be released and ignited in case of a fault. It is in the relative advantages and disadvantages of the various bus constructions that widest divergence of opinion is expressed by authors of the papers.

All designs have the generator or one unit step-up transformer neutral grounded, several of them using a reactor in the ground lead. The latter plants make full use of isolated metal housings, thus securing predetermined paths for fault current and definite applications of bus-fault relaying. Practically all generators and auto-transformers are relayed differentially as a unit.

All plants have an excellent record for continuity of service and an exemplary standard of safety for operating personnel. Higher voltages for busbars at the generation station, and for generators, are becoming more evident. There is a marked tendency toward greater use of metal housings for circuit breakers and busbars, with ground-fault protection and an increasing interest in the factory-built complete unit. All the authors look forward to greater simplicity in switching layouts, improvement in design details, and perhaps further approach to the unit principle.

Hudson Avenue Station

C. M. Gilt, in his paper, "Switching at Hudson Avenue Station," says that the general principle of eliminating air as insulation in 27-kv. equipment has been successful, and it would appear desirable to carry the principle as much further as can be done without introducing more objectionable features, or too great a cost. With the exception of one or two porcelain bushing failures (not a part of the main bus or breaker equipment) the few failures which have occurred have been due to foreign material causing a flashover in air insulation.

The most serious failure took place recently when apparently an over-ambitious workman got some foreign material through the opening in the disconnecting contact barrier while a generator circuit breaker was down for maintenance. The flashover of the live bus insulator set fire to the protecting barrier and bus insulation, and to an oil filter press standing below, and most serious of all, caused the only electrical operating fatality of the station.

The results of these failures as contrasted with failures involving live parts in older cell-type breaker and bus construction, even at 6.6 kv., have demonstrated the superiority of the latter construction. Metal-clad switch gear, which was not available when the station was built, goes a step farther, but also has its disadvantages. It is doubtful whether metal-clad switch gear would have prevented this failure, and it is quite possible that the failure of the stationary disconnecting bushing would have released and ignited oil, resulting in a more serious fire. Closer fit around the disconnect bushing might have prevented the deposit of soot on the bushings on other breakers. On the other hand, it would be more difficult to cut clear damaged equipment to restore service, and the larger amount of inflammable oil or compound which might be released by failure would introduce some additional fire hazard. However, it is believed that complete surrounding of high-voltage parts by grounded metal is a step in the right direction in reducing risks of failure and preventing its spread should one occur.

Richmond Station

Among the conclusions drawn by Raymond Bailey and F. R. Ford in their paper, "Switching at Richmond Station," are those to the effect that experience with Richmond switching facilities during the last two years, with the breakers modified to their present arrangement, indicates that an adequate and safe installation has been attained. Continuity of service has obtained and there have been no undesirable outages of individual circuits for which switching facilities were responsible.

Ease of operation has been realized to a most satisfactory degree, due primarily to simplified arrangement of both 13.8-kv. and 66-kv. layout. It is believed that the straight, double-bus scheme, with selector oil circuit breakers, inherently gives maximum operating simplicity with reliability of service, and that the

cost is moderate for an important transmission and distribution center in a large metropolitan system.

It is believed that the following features should be kept in mind for future improvements in oil-circuit-breaker development:

1. Breakers should be capable of interrupting fault current of any magnitude within their rating a number of times without requiring inspection or maintenance.

2. It is highly desirable that the hazard from use of inflammable fluids be eliminated.

3. It is believed that oil-circuit-breaker bushings should be improved in design and construction to improve their performance as circuit-interrupting devices, and also minimize the hazard due to flying pieces of porcelain, in the event a bushing is disrupted.

4. It should be possible to improve oil circuit breakers as mechanical devices so that there will be fewer adjustments and replacements required to keep them in satisfactory operating condition.

5. It would also be helpful if circuit breakers could be arranged so that their contact parts could be inspected and replaced with greater facility than is possible with large equipment at present.

Long Beach Plant No. 3

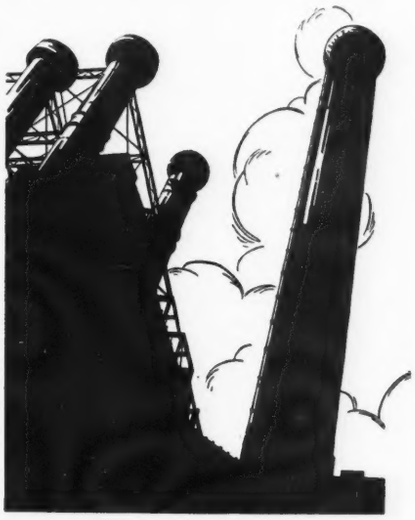
In the paper, "Switching at Long Beach Plant No. 3," A. A. Kroneberg, O. R. Bulkley and W. A. Andree pointed out that improvements in system stability is obtained by speeding up switching through purchase of fastest available switches and changing of certain details of existing switches. Magnitude of short-circuit currents is controlled by sectionalizing the system interconnection. Special attention is given to methods of regaining stability after synchronism has been lost. Results of extensive investigations indicate that switching surges can be reduced if the transformer banks are energized and de-energized from the low-voltage side. Synchronizing by means of 220-kv. circuit breakers is being accomplished at Long Beach No. 3, and at other points on the system.

Generators and transformers at Long Beach plant are equipped with standard-type differential protection. The transformer differential relays trip all high- and low-voltage oil circuit breakers on the unit, and the generator-field circuit breaker. A differential operation of the generator relays trip the low-voltage circuit breaker, the field breaker, a breaker in the neutral ground connection, discharges tanks of carbon-dioxide into the inclosed ventilating system of the generator, and stops the motor-driven air blower. An atmosphere of 25 per cent carbon-dioxide can be maintained for 30 min. in the generator. No overload protection is used with the units to avoid trip out on loss of synchronism. Past experience indicated that overload relays invariably operated on loss of synchronism, and since separation is made at the substation it was desired to keep the units on the line during out-of-step conditions.

Each bus or section of bus, where buses are sectionalized by oil circuit breakers, is equipped with three-phase differential protection. Bus differential type protection used by the Southern California Edison Co., Ltd., has a perfect record of 100 per cent correct operation. Differential protection is unquestionably the best method in existence, but, unfortunately, the very nature of the connection limits its application to equipment located in one station.

Conners Creek Plant

A. P. Fugill, in his paper, "Switching at the Conners Creek Plant," states that when the design of Essex Station, which



is adjacent to Conners Creek, was first considered, certain fundamental features were recognized as being highly desirable. These are:

1. Interrupting duty of circuit breakers with ultimate generating capacity, should be kept within rating of present-day circuit breakers by some scheme which would not interfere with effective interchange of power between the station and system.

2. All equipment in the station, particularly circuit breakers, should contain a minimum of oil or compound. Experience has indicated that much of the serious damage in indoor switch houses is due to oil fires, and that oil circuit breakers are the most likely offenders.

3. All faults, including those directly on the bus, should be cleared rapidly and positively. Instantaneous relaying for feeder faults had been in use for many years, but until recently no simple yet positive method was available for clearing bus faults promptly.

4. Bus-fault current should be kept to a predetermined adequate path and not allowed to roam at will through the building. Two or three previous disagreeable experiences have shown that fault currents in reinforcing bars can do considerable damage to concrete at the most unexpected places.

5. The building construction should be entirely divorced from the electrical installation. Since two classes of workmen are required for these functions, it is felt that time and money can be saved if each class could complete its work without interference with the other group.

The description of the station given in the paper indicates that the fundamental design features mentioned as being desirable have been incorporated in the station as designed and built. These may be summarized as:

1. The connection diagram chosen provides fault-current limitation without handicapping power interchange between station and bus system.

2. Possible damage from oil fires is reduced to a minimum by the use of H-breakers or Deion breakers, air-cooled reactors, and air-insulated buses, and by grouping breakers in small rooms.

3. Rapid, positive clearing of bus faults is secured by inclosing all electrical equipment in isolated metal housings and by bus-fault relaying.

4. Bus-fault currents are kept in a predetermined path by using isolated metal housings and a low-impedance ground network of copper and building steel.

5. Metal housings and armored control cables permit building construction and electrical installation to be distinct and separate operations.

State Line Station

At the State Line station an outdoor oil-filled metal-clad 22-kv. switch gear for main-generator bus is used. After describing this station in his paper, "Switching at State Line Station," T. C. White points out that the popularity of compact outdoor-oil-filled metal-clad switching equipment has steadily increased in the Chicago district, and much experience in design and operation has been obtained.

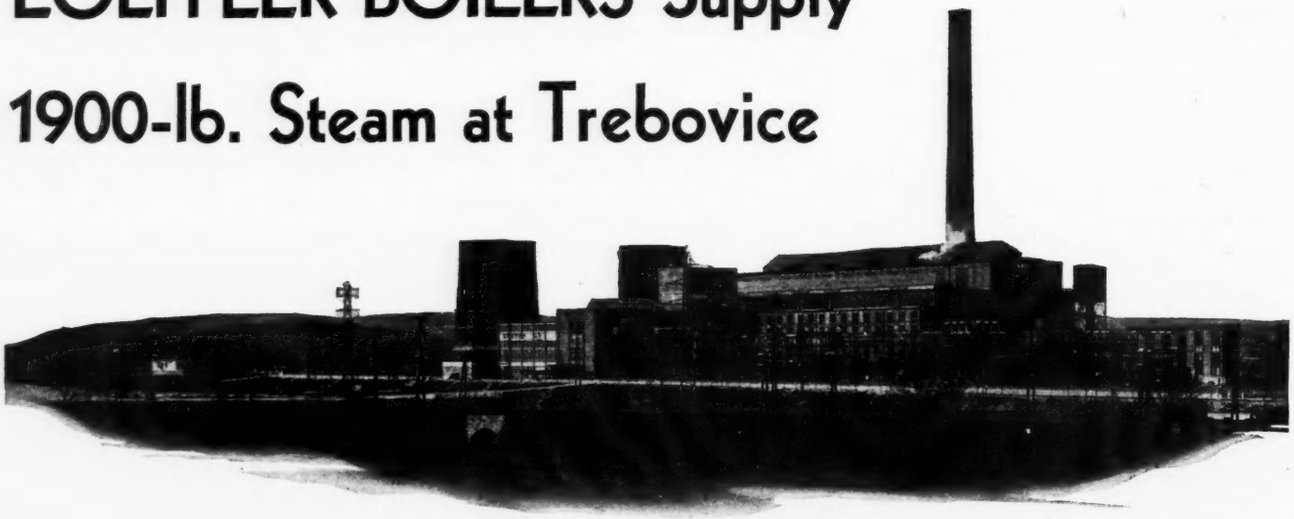
Recent developments of outdoor metal-clad gear have tended toward use of more compact factory-assembled units which may be shipped completely filled with oil. Manufacturers are now also offering gear with stationary breakers which use oil-immersed knife switches or movable conductors for isolating the breaker, instead of providing for isolating by vertical movement of the entire breaker. However, experience with the movable breaker scheme has been satisfactory at State Line, and would seem to be simpler where disconnection is required only for work on the breaker. If, however, frequent disconnection is necessary to provide an additional visual break in a circuit, for work beyond the breaker, facilities should be provided for doing this without using portable elevators.

The large number of gasket joints used in oil-filled metal-clad gears, and the inconvenience of replacement, makes it very desirable to simplify as far as practicable such joints and to develop gasket materials of more lasting quality and easy application than those available at present.

The use of silver to silver contacts for a disconnecting switch and brazing or welding of all possible joints within the gear are desirable developments.

The use of the indoor-metal-clad gear, especially at voltages around 2,300 volts, is becoming well established, being used exclusively at State Line, Powerton, and Michigan City plants. Public Service Co. of Northern Illinois is using considerable indoor metal-clad equipment, ranging up to 18-kv. The apparent trend in the case of indoor equipment up to 15-kv. is to use tape or molded insulation with air, instead of oil or compound, resulting in simplicity and greater safety from fire.

LOEFFLER BOILERS Supply 1900-lb. Steam at Trebovice



SINCE February, 1933, the Trebovice power plant has been operating with steam at 1,900 lb. pressure and 932 deg. F. In addition to these unusually high steam conditions, this plant is of particular interest because of its use of the Loeffler system of generating steam.

The station is the property of the Middle Moravian Electricity Works of Prerau and the Moravian Silesian Electricity Works of Moravska Ostrava. It is on the right bank of the Oppa River, about a mile from the railroad station of Schoenbrunn-Witkowitz. The plant has been laid out for an ultimate output of 150,000 kw., the first section of 45,000 kw. now being in operation.

Coal is received by railroad and is unloaded for storage by a traveling bridge crane of 147-ft. span and 50 ton per hour capacity. Stored coal is transported as required to the boiler house by a belt conveyor which runs alongside the storage space and delivers coal to an elevator. The elevator delivers the coal to a cross belt at the height of the raw coal bunker; after passing weigh scales, the coal is distributed by belt conveyors to the bunker. An auxiliary plant has been provided which bypasses the coal-unloading bridge and the main conveyor, delivering coal directly to the elevator.

From the bunker, raw coal drops through chutes to magnetic separators, after which it is fed to pulverizers. These mills have a power consumption guaranteed not to exceed 24 kw. per ton of coal. In passing through the mills, the coal is dried by flue gas taken from the boilers. The coal is then elevated by fans into cyclones which distribute it into the powdered coal bunkers. Dust-laden gas from the cyclones is delivered by fans into the boiler furnace. The coal (which has a heating value of 12,600 B.t.u.) is fed from the bunkers by nine bucket wheels to turbulent-type burners which mix the fuel with highly preheated combustion air. Two of the Loeffler boilers are provided with mills of 5-ton-per-hour capacity, four mills being arranged to supply each of these boilers with 10 tons of coal per hour. The third Loeffler boiler has a single mill of 10-tons-per-hour capacity.

Ordinarily, each mill serves its own boiler, but arrangements are made so that any mill may serve any boiler. This has necessitated cross-connecting ducts for drying gases and for the exhaust from the cyclones. The pulverized coal bunkers are also cross-connected through screw-type conveyors.

The three Loeffler boilers supply 135,000 to 165,000 lb. per hr. of 1,900-lb. pressure, 932-deg. F. steam to the turbines. Each boiler has a furnace lined with tubes of the radiant superheater, a convection superheater, an economizer and an air preheater. Evaporation takes place in three drums of 43-in. inside diameter, 26 ft. 4 in. long.

Feedwater enters the economizer section with a temperature of 385 deg., and is heated to 500 deg. At this temperature, it enters the steam drum and is vaporized by superheated steam taken from the superheater section of the boiler. The saturated steam thus produced has a temperature of about 628 deg. The saturated steam is forced by steam circulating pumps through the radiant and convection superheaters, where its temperature is raised to 932 deg. The major portion of that steam,

Three Loeffler boilers in the Trebovice power plant, Czechoslovakia, are fired by pulverized coal and supply 1,900-lb. steam at 932 deg. F. to two 21,000-kw., 3-cyl. tandem-compound turbine-generators

about two-thirds, is piped back into the vaporizer, and the balance, about one-third, enters the main steam main for use by the high-pressure turbines.

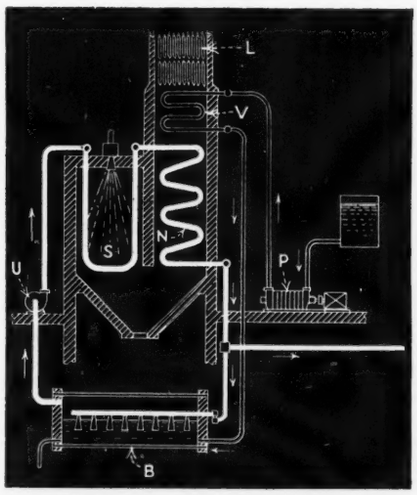
A diagram of the Loeffler system is shown. The steam generating drums for each boiler are located just under the boiler room operating floor and in front of the boilers, which are arranged in a single row.

There are three steam-circulating pumps on the boiler-room operating floor, direct-connected to steam turbine drives. Speed of these pumps must be controlled manually in accordance with boiler load.

The heating surface of the various sections of each Loeffler boiler is:

Radiant superheater ..... 1,216 sq.ft.
Convection Superheater .....10,190 " "
Economizer ..... 6,640 " "
Air preheater .....26,900 " "

In addition to the three main boilers, there are two auxiliary boilers each having a capacity of 22,000 to 27,000 lb. of steam per hour, and operating at 330 lb. pressure and 660 deg. These boilers supply makeup for the Loeffler system, and are also necessary for starting up the plant in case of a complete shutdown. Under such circumstances they would supply steam for the first filling of the Loeffler system, steam for operating the steam circulating pump, and steam for operating the house turbine up to the time the main Loeffler system is in operation.



Loeffler system of steam generation, shown diagramatically.

B evaporation drum; *U* steam-circulating pump, *S* radiant superheater, *N* convection superheater, *V* economizer, *P* feed pump

These boilers are of the sectional type and have grates, so that they are independent of the coal-pulverizing plant. During normal operation they carry a load corresponding to the feed-water makeup required. The balance of medium-pressure steam required to drive the house turbine and the turbines of the Loeffler circulating pumps is bled from the main turbines.

There is also a steam-reducing station which automatically throttles high-pressure steam to 300 lb. pressure whenever such steam is not supplied by the house boiler at the proper time, or in sufficient quantity. Desuperheaters are also provided which reduce the temperature of the reduced-pressure steam to 660 deg.

Feed-water makeup for the low-pressure boilers is taken from the river, and, after filtering, is softened in a zeolite system. The steam generated by these boilers and used in the house turbine is condensed, and the condensate is mixed with that of the two main turbines, thus supplying makeup for the high-pressure system.

Condensate from the main turbines is heated in four stages by steam bled from the main unit and exhaust from the steam circulating pumps. The first bleeder heater raises the temperature of the condensate from 105 to 160 deg. A deaerating heater supplied with exhaust steam from auxiliaries then raises the temperature to 220 deg. Steam extracted from the medium pressure cylinder of the main units increases the temperature of the condensate to 340 deg., and finally steam from the high-pressure cylinder raises the feed-water temperature to 410 deg. At this temperature, the feed water enters pure water tanks constructed for a pressure of 330 lb., and capable of storing 1,766 cu.ft. of water each. Into these tanks is also collected the condensate from the resuperheaters.

The feed pumps receive hot water from these pure water tanks and deliver it to the economizer section of the Loeffler boiler. They each have a capacity of 3,886 cu.ft. of water per hour, and raise the pressure from 330 lb. to 2,250 lb. The electrically operated pumps are direct-coupled to 3,000-r.p.m. motors. The steam-driven pumps are operated at 4,500 r.p.m. The turbine receives steam from the low-pressure boilers, or steam extracted from the main turbine, as circumstances require.

There are two main 3-cyl. Skoda turbines designed for 1,860 lb. pressure and 900 deg. temperature. Each turbine has a rated capacity of 21,000 kw. and can carry a short-time peak of 23,000 kw. At full load, a total of 66,000 lb. of steam per hour may be extracted, at 13.5 lb., 150 lb., and 460 lb. abs. pressure. The steam bled from the turbine is mostly used to heat the feed water, but also is used in part for the 3,500-kw. house turbine and other auxiliaries operated with steam at 300 lb. pressure.

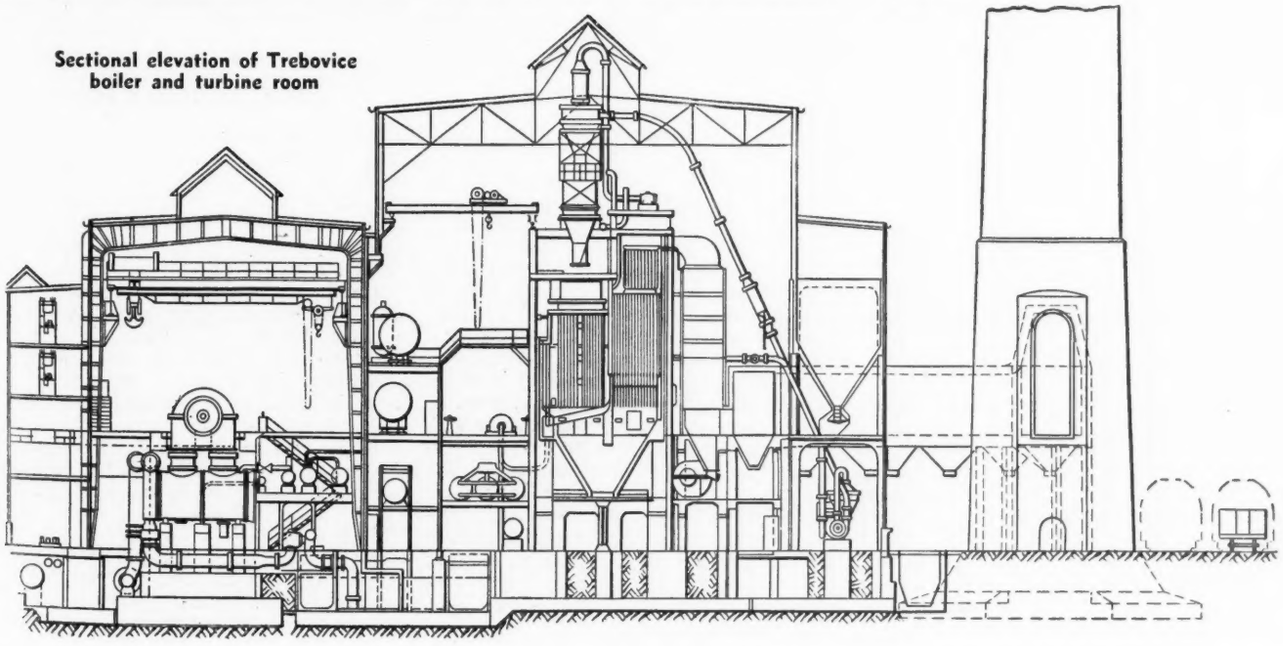
Steam is reheated between the first and scond cylinder of the turbine to 645 deg. Reheating is done in a steam reheater which uses high-pressure, high-temperature steam for the purpose.

The reheaters, one for each turbine, are designed on the counter-flow principle. Steam to be heated flows in pipe coils of about 5-in. inside diameter. The high-pressure, high-temperature, heating steam flows through 1¼-in. pipes that are inside of the 5-in. pipe.

The three cylinders of the main turbines are tandem-compound with blades of the impulse type, except for one Curtiss wheel in the high-pressure cylinder. Load is controlled by four regulating valves which regulate the steam to four groups of nozzles.

It has been calculated that the station heat rate of 13,000 B.t.u. per net kw.-hr. will be secured when the plant is loaded 70 per cent.

Sectional elevation of Trebovice boiler and turbine room



READERS' PROBLEMS

QUESTIONS for Our Readers

Increasing Plant Output

QUESTION 1

WE HAVE *a 7,000-kw. turbine arranged to bleed steam at two points for heating feedwater to 325 deg. F. Our fuel-burning equipment, however, has only sufficient capacity to produce enough steam for generating 6,500 kw.—a few hundred additional kilowatts of load causes steam pressure to drop. Will we be able to carry more load on our turbine-generator if we decrease the steam bled to the high-temperature feedwater heater, thus allowing more steam to flow through the turbine to the condenser but decreasing the final feedwater temperature? Piping conditions prevent our trying this, and before making the changes necessary we would like the opinion of* POWER *readers.*—J. A. D.

Lifting Shaft With Field Frame

QUESTION 2

THE END BEARING *of an engine-driven generator was removed by lifting the field frame on its raising screws so that the shaft freed the bearing for removal. A 10-ton flywheel was on the shaft near the armature. Thus the field had to support this weight in addition to that of the armature and shaft, the crank end being lifted by a jack. The question was raised whether this was good practice whether it should be generally used in making repairs and erecting. I would appreciate hearing from some readers of* POWER *regarding the advisability of lifting the armature in this way and the possibility of damage to the armature and pole-pieces. If we did not do the job properly, how should it have been done? Do the electrical machinery manufacturers recommend this practice?*—F. H.

Suitable answers to these questions from readers will be paid for if space is available for their publication.

Internal or Zeolite

RELATIVE COSTS OF INTERNAL AND ZEOLITE TREATMENTS—*Can you give us any information as to the relative cost of operation of internal boiler feed-water treatment and zeolite treatment? This for supplying water to a boiler operating at 150 lb. pressure, using approximately 1,000 gal. make-up water per hour. The raw water in this case is about 20 grains hard, containing 8.12 gr. per gal. of magnesium sulphate and 3.33 gr. of calcium sulphate. Any information you can give us as to the cost of these two methods of feed-water treatment will be appreciated.*—T. E. S.

[The following reply was prepared for POWER by William J. Ryan of the Water Service Laboratories, Inc., New York City —Editor.]

Probably the cheapest internal treatment to use with this water would be soda-ash, and the analysis indicates that the amount required would be approximately 1.5 lb. per 1,000 gal. of make-up water.

A zeolite softener of the most up-to-date type will use about 0.45 lb. of common salt per 1,000 grains of hardness removed from the water. Therefore to soften the water described above the amount of salt required would be 9 lb. per 1,000 gal. of make-up water.

The comparative costs for chemicals will therefore depend on the delivered prices of soda-ash and salt.

In addition to the costs for chemicals, there will be certain other costs that can only be evaluated by taking into consideration the operating conditions in this particular plant. For example, there will be a charge for interest and depreciation on a zeolite softener installation. On the other hand, with the internal treatment, while it should prevent formation of hard scale, there will be an appreciable amount of soft deposit and sludge which will necessitate shut-downs for boiler cleanings.

A comprehensive answer can only be made in any specific case when all the circumstances are known.

Steam Saving

HOW MUCH STEAM WILL HIGHER PRESSURE SAVE?—*We now operate steam engines with a throttle pressure of 125 lb. (saturated steam) and a back pressure around 5 lb. Exhaust steam goes to process and heating, but substantial quantities of steam are wasted during the summer months in order to carry the power load. It has been suggested that we install new boilers and engines for substantially higher pressure to eliminate this waste. Can you tell me how much the steam consumption of the engines would be reduced if the pressure were raised to 150 lb., 200 lb., 250 lb. or 300 lb.?* R. D. N.

If you are considering going to the expense of new boilers and engines, a minor pressure increase (as to 150 lb.) should not be considered, as the saving would not justify the investment.

Assuming that the new engine is of the same type, and in the same condition, as the old, its steam rate should change with the throttle pressure in about the same proportion as that of an ideal or perfect engine. For 20 lb. absolute back pressure (4.7 lb. gage) and no initial superheat, the steam rate of an ideal engine at various pressures will be about as follows; the third column showing the per cent saving of steam as compared with 125 lb. steam pressure:

Initial pressure Lb. gage	Steam rate, lb. per kw.-hr.	Per cent Saving of steam
125	23.5	. .
150	21.5	9
200	19.5	17
250	17.5	26
300	16.5	30

Heat of Liquid

HEAT OF THE LIQUID.—*Why is it that I can find the heat of the liquid at low pressures by subtracting 32 deg. from the saturation temperature, but for high pressures this procedure yields a result that does not check with values given in the steam tables? For example, at 16 lb. abs., the saturation temperature is 216.32. The heat of the liquid as given by the steam table is 184.3 B.t.u., which checks with 216.3 — 32 = 184.3 B.t.u. At 150 lb. pressure the heat of the liquid from the steam table is 330.4 B.t.u. and the saturation temperature is 358.4 deg. The calculated heat of the liquid is 358.4 — 32 = 326.4 B.t.u., which does not check the steam-table value.* A. N.

Calculating heat of the liquid by subtracting 32 from the saturation temperature is used quite generally by engineers to obtain a rough figure. The method will not give accurate results, as you have shown in the example given.

This is because it assumes a constant specific heat of 1.00 for water at all temperatures. This is an erroneous assumption as the instantaneous specific heat varies with the temperature. For example, at about 170 deg. the specific heat is 1.00, while at 600 deg. the specific heat is about 1.17. To find the heat of the liquid it is necessary to use the mean specific heat of the liquid between 32 deg. and the saturation temperature. This involves the calculus and it is much easier to consult the steam tables when an accurate value for the heat of the liquid is desired.

Power to Drive a Fan

INCREASING FAN SPEED OVERLOADED MOTOR—*We have a 5-hp. motor that was driving a fan at 680 r.p.m. To increase the air circulation it was decided to increase fan speed to 700 r.p.m. We had no means of making a test on the motor, but from its temperature it was evident that the motor was operating considerably under full load, probably about 4 hp. After the speed was increased, the motor's temperature increased to a value that would indicate that it was heavily overloaded. It was then decided to reduce the speed to 650 r.p.m. At this speed the motor operated at a safe temperature. Why was the increase in load so great for the comparatively small increase in speed?* W. R.

Power required to drive a fan does not vary as the speed but as the cube of the speed. On this basis, if the motor were loaded to 4 hp. when the fan was running 600 r.p.m., at 700 r.p.m. the load will be

$(700^3 \times 4) + 600^3 = 6.4$ hp., which is almost a 30 per cent overload. At 650 r.p.m., motor load is about 5 hp., provided the load was 4 hp. at 600 r.p.m. To assume that power to drive a fan increases as the speed is a quite common mistake, and some seriously overloaded motors have been the result.

WHAT PRICE EXHAUST STEAM?

ANSWERS to December Question 1

THE QUESTION

I SUPPOSE *all* POWER *readers will agree that the cost of electricity generated by a steam engine or turbine is the total cost of operating the unit (including steam) less a credit for exhaust steam supplied to heating system and process. Many plants credit the exhaust steam at slightly less than the unit cost of live steam, knocking off 5 to 10%, say, to allow for heat removed by the engine. I question the correctness of this practice, but not on the basis of any quibble about the exact percentage of this small correction. My difficulty is, rather, that during part of the year some exhaust steam is wasted in most plants. Why charge a factory department practically full live-steam rate for soaking up part of this waste by more liberal use of exhaust steam at such times?*

Is there any system of exhaust steam accounting that will get around this difficulty?—H. O. H.

Charge Process Steam on Basis of Heat Cost

WHEN STEAM is used after passing through a prime mover, its value should be based on its heat content. The amount can be determined from the cost of generating an equal quantity of heat in the form of live steam.

Should a reduced rate be made to a department for a more liberal use of exhaust steam at times of waste to the atmosphere, it would simply mean that the prime mover is being charged with whatever amount department cost is reduced. In the end, the net gain would be zero.

By using some of the exhaust that might be wasted; power generation cost could be reduced. If power generation should cease, then the department would buy heat, as live steam, and would be charged accordingly. So that, regardless of the use of exhaust steam by a department, its cost should always be based on the cost of producing heat as live steam.

Baton Rouge, La. G. F. MATTHES, *College of Engineering, Louisiana State University.*

Charge 90 Per Cent to Process And 10 Per Cent to Power

A RATHER CAREFUL study of a plant in which exhaust steam was used for heating revealed that at all loads, from practically zero power load to maximum, the heat actually used for power and for heat was divided in the ratio of ten per cent to power and ninety per cent to heat. Since industrial plants may usually be regarded as combination plants producing both power and heat, neither of which is a by-product, it would seem only fair that each bear its share of the cost. The actual pressures and temperatures prevailing in a plant will determine the proper apportionment, but in any ordinary case the proportion will not differ much from the figure given.

Corvallis, Ore. WALLACE H. MARTIN.

Don't Waste Process Steam

ANY ATTEMPT to measure the human factor, as exemplified by factory department operators, by formula would result in an accounting system of questionable accuracy. While it is possible from periodic tests to compute curves based on outside temperature (in the case of the heating load) and on production (in the case of the process demand), these curves would be inaccurate because of the waste from poor operation for which the factory department should be charged.

To secure the greatest economy in operation, all steam supplied to the factory should be metered by flow meters. The various departments should then be educated to use the minimum amount of steam necessary to secure quality product from the process and proper regulation of the heating system. The steam, as recorded by the meter, could then be honestly charged to the factory or department, making due allowance for degradation of heat by the engine. Any excess exhaust steam which must be wasted should be wasted at the power plant and charged to the cost of electricity.

With the waste centralized, its control would be left to the engineer, who could take steps to eliminate the losses as much as possible. There are any number of possibilities for recovery of waste if its magnitude and cost are known. Among these possibilities are improvements in the heat balance by balancing the electrical and steam demands, purchase of new equipment if the investment is justified, or if it proves economical the purchase of power at times when the steam load is at a minimum.

Waynesboro, Va. S. H. COLEMAN.

Charge for All Power Services

ALL POWER and steam services should be charged to the various departments at cost, total costs to include all operating costs and carrying charges on the investment.

If the various departments are charged for electricity consumption alone, with the prime mover exhausting against a back pressure, the cost per kw.-hr. to the departments would probably be greater than it would be if the services were supplied by a central station.

Whereas, with a charge made for exhaust steam and the value of the exhaust deducted from the steam charge against the prime mover, the cost per kw.-hr. would be lower than the cost of generation at a central station.

Even though some of the exhaust steam is wasted to the atmosphere during a part of the year, it is possible that more than 50 per cent is consumed. This is a large item in the costs of the power plant.

A power plant can only be a profitable investment when it is supplying its service at a lower cost than that for which the same services can be purchased elsewhere. Therefore, all services should be charged for at cost.

Cleveland, Ohio. THOMAS C. BROOK.

A CHEAP SMOKE INDICATOR

ANSWERS to December Question 2

THE QUESTION

I OPERATE *a heating plant in a store building in a large city. Smoke regulations are strict and neighbors watchful, so it is desirable that we avoid visible smoke. What cheap system can we use to discover smoke emission and signal me when it occurs, its duration and its density? Wouldn't a breeching indicator be preferable to a stack unit?*—W. J. T.

Mirrors and Prisms Will Work

I WOULD suggest that a system of mirrors and prism deflectors could be arranged to make the belching of smoke visible to the fireman. After a little study of cause and effect, it should be easy for him to arrange his draft and checks and to adjust the method of firing to produce a minimum of smoke. This is of course feasible in daylight only when the smoke is visible. Under the circumstances, this is probably all that would be necessary. A movie camera set to make 4-10 exposures per minute would give a visible record of the "smoking" or "non-smoking" condition of the chimney for any desired period of time.

Pittsburgh, Pa. BERNARD KRAMER.

Use a Photo-Cell Device

THE SOLUTION of this problem is a photo-electric cell control device of the type shown in Bulletin No. 13,111 of Cutler-Hammer Co., Milwaukee, Wis. Consist-

ing of a light source, a photo-cell unit and a control panel, this arrangement may be made to operate relays to sound a horn, bell or operate an electric light at any distance from the boiler room. Of course the breeching location for light source and cell is preferable.

Duration of the smoke can be shown on a recording meter and its intensity by the same means. An audible signal of intensity and duration could be given by means of a radio loudspeaker of the type used by General Electric engineers at an A.S.R.E. dinner at the Hotel New Yorker, New York, N. Y., Dec. 7, 1933. The equipment operates by interruption of the light beam, by establishing the beam, or by changing its intensity. These can be varied over wide ranges, and the unit operates on commercial circuits, is easy to install and operate, and is rugged in design.

Bayside, N. Y. WILMER T. MEINZER.

Simple Periscope Does It

A MIRROR set in the base of the stack at an angle of 45 deg. will reflect daylight coming down the stack in a horizontal direction. The beam can be caught on another mirror in sight of the fireman. The writer has known of an installation of this kind which was satisfactory in the daytime, and at night the smoke was not complained of so much because it could not be seen. However, a light protected from the heat of the gases but in sight of the mirror, could be installed in the stack or breeching which would make the method effective at any time.

The idea suggests itself that this would be an excellent situation in which to install an "electric eye." In that case, any degree of automatic control could be obtained, depending on how much the owner desires to spend.

Corvallis, Ore. WALLACE H. MARTIN.

Economy as Well as Nuisance

SMOKE-DENSITY measurement is one service for the "electric eye." An incandescent lamp is placed on one side of the breeching. A reflector behind it shows a spot on the opposite side of the breeching. The reflector is preferably tilted down somewhat to prevent accumulation of soot. In the spot of reflected light is placed the photo-cell. It is probable from the specifications that a recording system would be best. Various types of bell and light alarms are available and may be easily adapted to a recorder to give warning if the pen reaches a predetermined maximum value. At least two types of photo-cell smoke instruments have been advertised in recent issues of *Power*.

This question should also be considered from another angle. If this plant is of such size that the fuel bill exceeds about $2,000 a year, it would be well to consider the smoke question from the standpoint of economy as well as nuisance. Excessive black smoke is a sign of improper combustion and shows a distinct loss. Control of this loss will simultaneously control the smoke elimination. This plant should, if fuel bills exceed the sum mentioned, give careful consideration to either a CO_2 recorder or a boiler meter of the type showing the relationship between steam flow and air flow. Installation of such instruments will certainly be warranted on the basis of self amortization out of savings in operation.

Waterville, Me. HARRY M. SPRING, JR.

Visual Unit Recommended

A UNIT installed in the breeching or last smoke pass of the boiler is preferable, because the indications will be given 20 or 30 sec. before the changes in density they represent can be observed at the top of the stack. A visual unit is also recommended in combination, with its observation member placed conveniently where it can be seen as easily as the water and steam gages. This *shows* the operator just when smoke is being made, and also

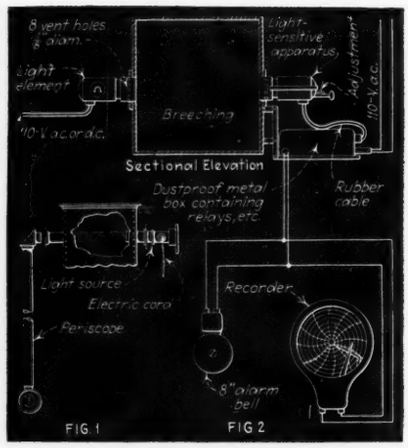


FIG. 1 FIG. 2

indicates its density. Fig. 1 shows such an instrument. It may be made simple and inexpensive, or more elaborate, as plant conditions may require.

An arrangement employing a photo-electric cell, as in Fig. 2, may form one part of the combination. This may be arranged to alarm, or to record, or to do both, as may be preferred—as well as to keep a true reading of the density of the escaping gases before the eye of the observer.

By the use of the visual unit in combination with the alarm and recording system, actual violations of a predetermined maximum density may be minimized or prevented, because the operative can see the approach of a condition of objectionable smoke density and make such adjustments as may be called for to forestall it.

Likewise, another refinement may be introduced whereby the alarm may be sounded just before the density reaches the objectionable point, making it possible to avoid the necessity of recording such a condition—and thus making an expensive recorder superfluous in most cases.

Chicago, Ill. T. W. MCNEILL,
T. W. McNeill Engrg. Equip.

A Window May Do It

FROM the inquiry it would appear that this plant is so equipped that it smokes only at intervals—when picking up a peak load or when cleaning fires. Under these conditions, an expensive recording meter installation may not be justified, and I would suggest that some means be adopted for the fireman to see the stack. This can be done either by a periscopic arrangement or by cutting a window in the boiler room. If, however, it is physically impossible to do this, then you can install a registering device. These instruments are based on the use of the photo-electric cell or merely a beam of light made to pass through the interior of the stack or breeching. For complete information, I refer you to Ess Instrument Co., 30 Church St., New York, N. Y., or to General Electric Co., Schenectady, N. Y.

The former company has specialized in these instruments and has developed them into good boiler-room apparatus. The meters can be installed either as continuous recorders or as alarms to warn by means of a light or a bell when dense smoke is being discharged. The installation is generaly made in the breeching because of accessibility and because located there it gives the fireman a few-second warning before the smoke appears at the stack. The value of these instruments, however, is dependent entirely upon their proper and continuous use.

Woodside, N. Y. NORMAN L. KORN.

Depends on the Engineer's Electrical Ability

IF THE chief engineer is a good electrician, he can probably keep a photo-electric unit operating, or one which is based on the light-sensitive cell principle. The adjustments on this type of apparatus are very delicate and, therefore, it requires a careful man interested in instruments. If they do not have this type of man, it is more advisable to install a visual or periscopic type smoke indicator, which operates indefinitely without attention.

As to the question of whether a breeching indicator should be preferable to a stack unit, it is best to install any type as close to the boilers as possible, as infiltration and leakage of air into the flue gas system will not affect the color of the smoke at this point as greatly as it does at the stack.

New York, N. Y. H. L. PARRY,
Parry Engrg. Co.

Use Unit Described

THE PHOTO-ELECTRIC relay unit described in the June, 1933, number of *Power* and in use at the B. Altman Store, Fifth Ave., New York, would seem to be the most satisfactory method of indicating the emission of smoke. I would suggest that the indicator be installed in the breeching rather than in the stack itself.

While I am not familiar with the system described, the principle involved in such systems is simple. An ordinary light bulb is installed on one side of the breeching. The beam from this lamp passes across the breeching and impinges on a light-sensitive photo-electric relay, so constructed that it keeps an electric circuit open as long as the light beam is not interrupted. When smoke comes between the electric bulb and the light-sensitive ll it interrupts this beam of light and the photo-electric relay closes the electric circuit, causing the alarm bell to ring.

A recording galvanometer as well as the signal may also be installed and will give a permanent record of the time duration of smoke emission.

Bellerose, N. Y. HENRY C. OATLEY.

THE ENGINEER'S BOOKSHELF

I. C. Engine Theory

INTRODUCTION TO INTERNAL COMBUSTION ENGINEERING (1933). *By J. B. O'Sneddon, F.R.S.E., lecturer on heat engines at the Royal Technical College, Glasgow. Published by Longmans, Green & Co., 55 Fifth Ave., New York, N. Y.; 268 pages, 5x7½ in. Cloth; 152 diagrams. Indexed. Price, $2.50.*

Planned for college students and those trying to take associateship examinations in technical societies, this text endeavors to present in neatly assimilated form the thermodynamic side of internal combustion engineering. A large number of typical problems are worked out fully. Properties of gaseous and liquid fuels are included, as well as discussions of the phenomenon of detonation, charging and scavenging processes, and the various systems of supplying the fuel and introducing it into the cylinder. One chapter is devoted to engine testing, and includes descriptions of various types of indicators and brakes. Another deals with compressed air and its application to starting, maneuvering, supercharging and scavenging. This leads to the use of air engines on oil engine locomotives, in the final chapter. Illustrations are uniformly large and readable, and text is easy to follow.

A.S.T.M. Standards

1933 BOOK OF A.S.T.M. STANDARDS. *Published every three years by the American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa., in two parts. Part I, 1,000 pages, includes standards relating to metal. Part II 1,300 pages, covers non-metallic materials; 6x9 in. Complete index. Cloth, $7.50 per volume, or $14 per set; half leather, $9 per volume, or $17 a set.*

This two-volume set contains all the standard specifications, methods of testing, definitions and recommended practices adopted by the Society. Of the 175 standards in Part I, 104 cover ferrous metals, while 70 relate to non-ferrous metals and 11 involve metallography and general testing methods. Part II contains 285 standards, covering many widely used materials, including cement, refractories, coal, paint, petroleum products, rubber products, textile materials, etc. Supplements containing any standards adopted in 1934 and 1935 are furnished without charge to purchasers.

Power Economics

POWER SUPPLY ECONOMICS (1934). *By Joel D. Justin, consulting engineer, and William G. Mervine. Published by John Wiley & Sons, Inc., New York, N. Y., and Chapman & Hall, Ltd., London, England. 276 pages, 6x9 in. 19 tables; 58 illustrations. Price $3.50.*

A broad general treatment of the principles of power supply economics without technical details, is given in this book. It is written primarily for executives and engineers of power companies and industrial concerns who are responsible for providing a power supply. It is intended to answer such questions for these men as: Is our present cost of power the minimum obtainable with our existing facilities? What additional load must we be prepared to carry next year and year after next? To carry this additional load shall we build a new plant or purchase power? If additional capacity is required, shall it be steam, hydro or diesel? Analysis of these and many other similar questions are given consideration.

Steam, hydro and diesel-engine plants for public utilities, industrial concerns and municipalities are included. The long association of the authors with economic studies of power supply and their work in this field are assurance for a clear prospective in analyses made of the problems considered in this book. Those responsible for providing a power supply and students of engineering and economics should find this work a valuable asset.

Handbook

HANDBOOK OF CHEMISTRY AND PHYSICS (18TH EDITION). *Edited by Charles D. Hodgman, M.S. Published by Chemical Rubber Publishing Co., Cleveland, Ohio. 1,818 pages, 4⅜x6¾ in. Indexed and illustrated. Flexible fabricoid binding. Price, $6.*

So successful has been this standard handbook that it has gone through eighteen editions in its 20-year life. This has been of obvious advantage, because the information included is the most up-to-date procurable. Probably the best way to give an idea of its contents is to list them thus: 220 pages of mathematical tables and formulae, 800 pages of chemical tables, including physical constants of 4,000 organic compounds and those of 4,000 inorganic and metal-organic compounds, 44 pages on properties of matter, 135 pages on heat, 54 pages on sound, electricity and magnetism, 204 pages on light, 134 pages on measures and units. The remaining pages include tables and information of general interest. Tables include those on pH values for potentiometer readings, degree and radians, solubility chart, characteristics of thermionic tubes.

BRIEF REVIEWS

EDISON ELECTRIC INSTITUTE. *New publications of Edison Electric Institute, 420 Lexington Ave., New York, N. Y., are:* "Hydraulic Turbine Governors," Publication A-19 (Aug., 1933), discusses recent developments in design and operation. $0.50 to non-members. "The Economic Design of Hydro-Electrical Plants," publication A-18 (Aug., 1933) points out the path of development and shows savings possible in future developments based on recent experience. $0.50 to non-members. "Fault-Locating Methods Used on Underground Cable Systems," Publication A-12. Practices of various companies. $1 to non-members.

THE POSSIBLE PRODUCTION OF LOW-ASH AND SULPHUR COAL IN ILLINOIS AS SHOWN BY FLOAT AND SINK TESTS. *By David R. Mitchell. Bulletin No. 258 of Engineering Experiment Station, University of Illinois, Urbana, Ill. 44 pages. Price $0.50.*—Gives historical background, investigation, test procedure, tests on samples, results, summaries and conclusions.

MECHANICAL WORLD YEAR BOOK (1934). *Published by Emmett & Co., Ltd., 31 King St., West, Manchester, England. Price, 1s. net.*—New sections in the 1934 edition of this pocket-size year book include a section on metals and alloys, one on machine tools, another on press work.

INDUSTRIAL GAS RESEARCH.—*American Gas Association Testing Laboratory, 1032 East 62nd St., Cleveland, Ohio. Two new bulletins.*—The first, Report No. 723, "Research in Fundamentals of Combustion Space Requirements in High-temperature Gas Furnaces" includes 87 pages, and the second, "Research in the Elimination of Noise in Industrial Gas Burners," Report No. 724, includes 81 pages. Both are well illustrated and include bibliographies.

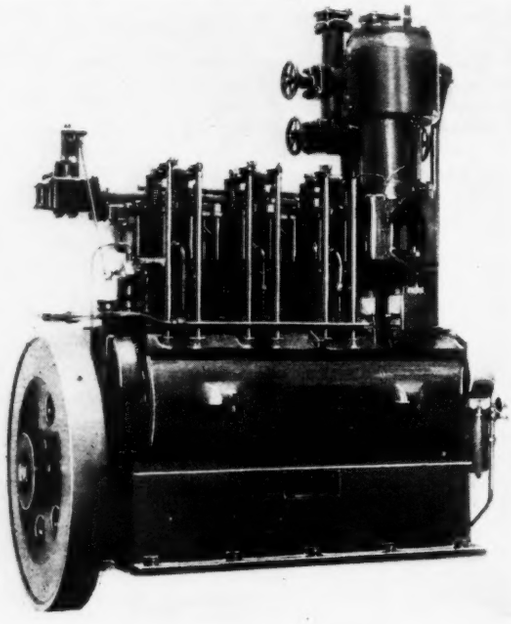
A.S.T.M. TENTATIVE STANDARDS (1933). *Published by the American Society for Testing Materials, Philadelphia, Pa. 1136 pages, 6x9 in. Paper $7, cloth $8.*—The 1933 edition contains 223 tentative specifications, methods of testing, definitions of terms and recommended practices covering materials of engineering, 34 on ferrous metals, 21 non-ferrous metals, 113 paints, insulation, etc., 45 on cement, lime, stone, concrete, etc. *Also "Index to A.S.T.M. STANDARDS AND TENTATIVE STANDARDS." Indexes 466 standards, 223 tentative standards.*

LAWS AND REGULATIONS RESPECTING STEAM BOILERS AND PRESSURE VESSELS (1933). *Published by the Department of Labour, Province of Quebec, Canada. 66 pages, 4x6½ in.*—Reprint of an act. Discusses inspectors, construction, certificates, inspection, penalties, fees, rules and regulations, and related subjects.

L'OEUVRE DE LA SOCIETE D'ELECTRICITE DE PARIS—*La Centrale St. Louis 2* (1933). A beautifully illustrated booklet giving statistics and vital information on the St. Denis station which serves the City of Paris, France. Address Paris Electrical Society, Paris, France, for copies.

NOTES ON SPALLING TESTS. *By Fred A. Harvey, Director of Research, Harbison-Walker Refractories Co. Technical Bulletin No. 42, dated September, 1933, of the American Refractories Institute.* Copies may be obtained by addressing F. M. Phelps, Refractories Fellowship, Mellon Institute, Pittsburgh, Pa.

WHAT'S NEW IN PLANT EQUIPMENT



Unit Diesel or Gas-Engine Refrigeration Compressors

"Unibloc" diesel or gas-engine compressor unit has compressor cylinder mounted directly on base of standard Worthington vertical four-cycle diesel or gas engine. Piston of one power cylinder is replaced by crosshead connected by piston rod to compressor cylinder directly above. High efficiencies result from elimination of mechanical friction, placing of suction valve in piston top, and adaptability of feather valve to higher speeds of operation. Lubrication of compressor piston and stuffing box by mechanical force-feed lubricator driven directly from one of engine valve push rods. Floor space requirements reduced to one-half. Smaller throw on refrigeration crank permits lower piston speed. Complete range of sizes for all types of refrigerants. In larger units, number of compressor cylinders is increased to obtain required capacity.

Worthington Pump & Machinery Corp., Harrison, N. J.

Cast Iron Welding Electrode

"Ferroweld" for welding cast iron by shielded-arc process gives weld with greater strength and ductility than cast iron. Has steel core surrounded by heavy flux coating, which protects arc from injurious gases. Can be used at low heat, thus reducing cracking. Welding is done intermittently, bead not over 3 in. long being laid at one time. As each bead is welded it is peened lightly, cleaned and allowed to cool before next bead is deposited. One size only, $\frac{1}{8}$ in., used with approximately 80-amp. current.

Lincoln Electric Co., Cleveland, Ohio.

Intake Gas Cleaner

Burgess air cleaner has replaceable filter cartridge which can be cleaned. Unit works on viscous-coated fiber principle using cellulose fiber filtering material. High cleaning efficiency and low air restriction. Maximum air velocity permissible 270 ft. per min. Two standard sizes, $5\frac{3}{4}$ diameter by $4\frac{1}{2}$ in. long, with capacity of 80 cu.ft. per min., and 9x7x12-in. flat unit with capacity of 290 cu.ft. per min. Either unit may be used in multiple for larger capacity. In photo, unit assembled at left, air filter unit at right.

Engineering Department, Burgess Battery Co., Madison, Wis.

Mercury Thermal Regulator

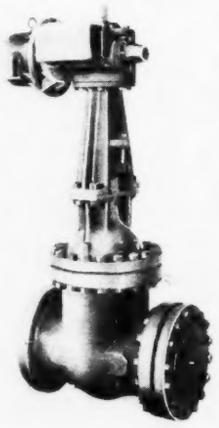
This sealed-type mercury-thermal regulator may be easily and accurately set at operating temperature without trial and error. To set, bulb is immersed in liquid at temperature at which regulator is to be set. Time is allowed for bulb to come to temperature, and surplus mercury is spilled off into side reservoir by a quick tipping motion. This operation sets regulator within 0.02 deg. C. Hence, sensitivity is plus or minus 0.01 deg. C., or better. Setting unaffected by 20-deg. overshoot in temperature. Intended for use with any relay that does not use more than 10 milliamp. operative current.

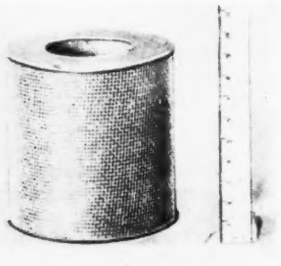
American Instrument Co., Inc., 774-776 Girard St., N. W., Washington, D. C.

Electric Valve Operator

"Limitorque" valve operator has control consisting of self-contained reducing gear unit with mechanical and electrical limit built in. Valve-operating nut that releases and lowers valve disk is incorporated in casing and supported by heavy-duty Timken roller bearing. 1800-r.p.m. motor is first reduced by low-ratio helical gear, then by steel-and-bronze worm gear. Entire mechanism immersed in oil and requires attention only after six months. Every moving part inclosed, dust and moisture proof, for operating in any atmosphere or outdoors. Three sizes which, with two motors per frame, permit six combinations. Valves of 3 to 72-in. diameter are operable by these units, and sizes from 3 to 24-in. are capable of pressures up to 600 and 1,000 lb. per sq. in. Unit is adaptable to every form of gate and globe valve, sluice gates, dampers, or other mechanism having definite movement which must be stopped or reversed at end of travel. Also adaptable to hand-operated valves. No external gears. Torque switch projects valve stem and operating parts against breakage, if disk is obstructed by foreign matter. Disk can be seated to any desired degree of pressure. Hand operation available without use of any magnetic or hand clutch by simply attaching hand wheel to extended shaft. Bulletin.

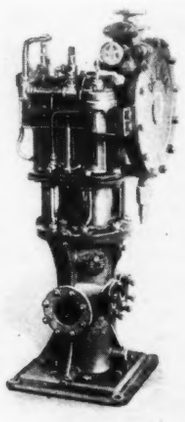
Philadelphia Gear Works, 330 West 42d St., New York, N. Y.





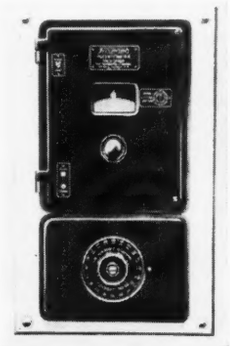
Steam Turbine-Driven Fuel-Oil Pump

Comprises De Laval-IMO pump set with vertical shaft driven through worm reduction gear by a high-speed steam turbine, which has its casing mounted on gear casing. Speed-reducing gear makes it possible to combine good steam economy with simplicity and low cost of velocity stage turbine with only one pressure stage, reducing steam consumption to about half that of ordinary steam driven pumps. Turbine speed controlled by small hydraulic governor operating throttle valve. Unit de-



signed for continuous operation. Oil for lubrication of worm and gear bearings and teeth is provided by a self-contained system, including filter through which oil is circulated by small IMO pump driven directly from worm shaft. Pressure differential maintained by this pump on a fixed orifice also serves as speed-governing medium. Gear casing ribbed to dissipate heat. Unit will deliver oil to burners or to lubrication system at any rate up to 500 g.p.m. No valves. Operates without shock or pulsation. Comparatively high speed. Only one shaft packing, and that not under high pressure.

De Laval Steam Turbine Co., Trenton, N. J.



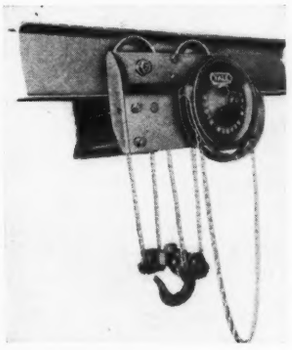
Indicating Potentiometer Pyrometer

This indicating pyrometer uses potentiometer system of temperature measurement. All adjustments centrally located on front cover plate. Pointer of galvonometer swings just above temperature dial and is brought to balance at same hairline index which marks measurement on temperature scale. Hairline is part of a glass window through which both pointer and scale can be seen at the same time. Thus balancing and reading instruments are practically one operation. 17-in. of scale length provided by 6-in. dial, to increase accuracy of reading. Plain black figures. Galvanometer suitable for rough industrial use with high accuracy. Double suspension type. Universal moisture-proof case. May be either surface or flush mounted, clamping device holding instrument tight to the panel without screws or bolts extending through. Thermocouple leads brought to a connection compartment, sealed from interior of case, and with openings for introduction of conduit if desired. By using selecting switch, indicator can be used to give temperature readings from any number of thermocouples at widely scattered points. Multiple-point rotary selector switches are simple in design, and can be furnished for flush or panel mounting as illustrated. Four-page bulletin No. 192.

Foxboro Co., Foxboro, Mass.

Low-Headroom Chain Hoist

"Rail Hugger" chain hoist has 75 per cent less headroom than standard type hoist with trolley. Either plain or geared type.



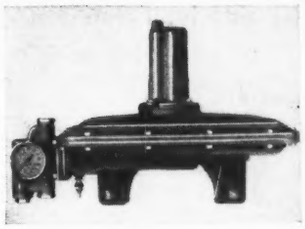
Spur-gear hoist mechanism, planetary system reduction. Gears mounted on bronze anti-friction bearings with oil duct lubrication. Steel suspension members. Screw and disk type; self-actuating load brake. Load sheaves mounted on ball bearings of radial thrust type with special alloy steel balls and chrome-vanadium races. Bearing inclosed with dust-proof metal and felt oil-retaining rings. Steel chains. Drop-forged steel load hooks. Chain guards prevent fouling of hand chain. Trolley frame consists of outer and inner steel plate, parallel with each other, connected and supported by a steel separator block and through bolts. Wheel bearings are Timken roller type. Hoisting gears oil and grease lubricated. Bearings and brake, oil duct, wheel lubrication by Alemite fittings. Capacities from 1½ to 10 tons.

Yale & Towne Mfg. Co., Philadelphia Division, Philadelphia, Pa.

Floor Resurfacing Material

"Stonhard Resurfacer" is mixed with sand and cement, then mortar is laid cold ½ in. thick. Material will bond to concrete, wood, brick, wood block, asphalt or composition floors, and ready for traffic 36 hr. after being laid. Will not dust and is resilient. In repairing concrete floors, chipping, roughening or acid-washing are not necessary. Low first cost.

Stonhard Co., 401 N. Broad St., Philadelphia, Pa.



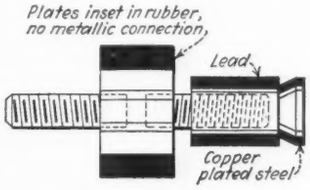
Draft Controller

Type 90 supersensitive draft controller is a fully compensated floating type unit. Primarily used on forced-draft boilers to maintain correct, constant low draft in combustion chamber. Actuated by slight variations in furnace draft; operated by water, air or oil under pressure. Frictionless bearing and no stuffing boxes, thus greater sensitivity. Reverses direction on 0.002 in. water. Small, compact, entirely enclosed. Bulletin 957.

A. W. Cash Co., Decatur, Ill.

Sound Isolating Bolt

"Sound - Stopper" comprises two elements, anchor and double stud with sound-isolating insert. Anchor is similar to expansion bolt of permanent type. Brass cone is dropped to foot of ¾-in. hole and steel sleeve,

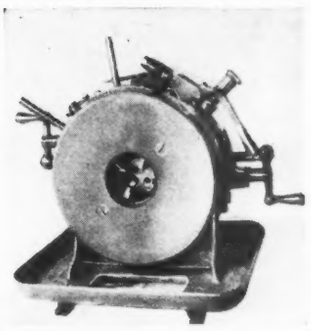


with lead exterior, dropped over it and driven down by means of special setting punch. Double-stud unit is then screwed into interior threads in steel sleeve. It comprises two studs in plates joined by vulcanized rubber cylinder, thus no metallic contact between stud ends. Machine is set on insulating board around sound-stopper unit and bolted to top half. This puts the sound-stopper in tension and provides sound - isolating mounting. Variety of sizes.

Walter J. Ottinger, 1893 East 55th St., Cleveland, Ohio.

Quick-Setting Die Head

In "Red - E - Quick" and "Double - Quick" die heads, quick die-setting is accomplished by drawing up a die controlling cam ring until desired one of a series of notches, representing various thread sizes within range of heads, is engaged by a pawl which locks and holds dies in correct threading position. Only two sets of dies required to thread all sizes of pipe from ½ to 2 in. One for



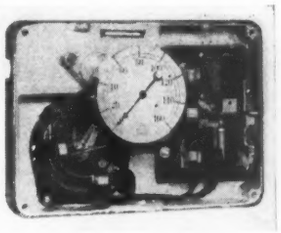
½ to ¾ in., other for 1 to 2-in. steel pipe. In "Double-Quick" die head illustrated, two sets of dies are so arranged that operator can select and set one or other without die changes. Plunger in head may be depressed so that a finger in its lower end projects into path of pipe as it enters dies. When standard, full-length pipe thread has been cut, end of pipe presses finger back and releases plunger, which in turn opens dies and frees pipe. This avoids necessity for backing off dies from threads.

American Die & Tool Co., Reading, Pa.

Circular Slide Rule

TASCO slide rule is especially adapted for carrying in vest pocket. Etched black lines on nickel-silver plate. Grease and waterproof and cleaned by washing. Average accuracy ¼ of 1%. Weighs 3½ oz. Disc 2¾ in. in diameter, length of multiplication - division scale — 6.3 in., as against 5 in. on "A" scale of regular 10-in. slide rule.

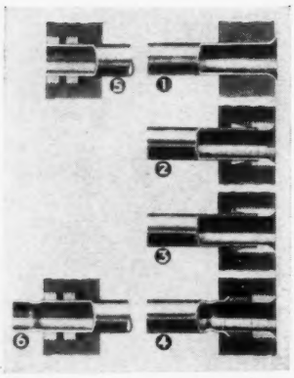
Tavelle Sales Co., 25 West Broadway, New York, N. Y.



Pressure Governors

Type CR-2922 pressure governors are especially adapted to pumping station service, but can also be used in industrial processes where it is desired to maintain a predetermined pressure. Adjustments can be made on governors between limits of 20 to 80 per cent of full-scale rating. Maximum differential is 60 per cent and minimum is 2 per cent of full-scale rating. Accuracy at a setting is 1 per cent of full scale.

General Electric Co., Schenectady, N. Y.



Tube-Fastening Method

These two new methods of tube fastening at inlet ends of surface condenser, cooler and heater tubes avoid former difficulties with rolled ends, yet fix tube firmly, allowing expansion entirely toward outlet tube sheet. Method of Fig. 2 uses gasket inserted in bottom of drilling, with soft Admiralty metal cone slipped over tube against gasket. Then hard Admiralty metal seat is slipped into cone. Against seat a streamline ferrule is screwed, so designed as to come flush with tube sheet. Alternate method, Fig. 3, consists of same gasket cone and special ferrule so beveled that it replaces seat and ferrule of method of Fig. 2.

Ferrule applies pressure against seat, compressing soft cone radially against tube diameter and giving perfect mechanical seal without measurable deformation, even in 18-gage tube. By using this method in combination with "John Crane" metallic condenser packing for outlet end, as in Fig. 5, it is possible for operator to remove tubes simply by removing ferrule, drifting tube through outlet packing and removing it from inlet end. Fitting parts are interchangeable and may be reused, and by careful drifting of tube through packing at outlet end, tube may be slid back and recaulked so that unit can be put back on line without leakage. Where erosion, aeration or tube metal thinning at inlet end are experienced, tube may be turned end for end.

Fig. 4 shows how tubes may become necked or damaged by applying pressure through screwed ferrules to an inferior fibrous packing. Fig. 6 shows these same tubes refitted by second method, moving damaged portion toward outlet end so that "John Crane" metallic packing may be used. Special tools provided for using. Parts should be same material as tubes to prevent electrolytic action, thus are available in all copper and copper-nickel alloys. Folder.

Crane Packing Co., 1800 Cuyler Ave., Chicago, Ill.

V-Frame for Filter

"V" frame arrangement for "Dustop" glass-wool air filters saves 40% of frontal area required by earlier "L" type or flat-intake face. Units set up in steel frame in a series of "V" angles arranged to avoid turbulence of air flow. Gives 40% increase in air capacity without increasing frontal area or decreasing efficiency. Uniform throat opening insures even distribution of air over frame. Utilizes new form of "bayonet lock" which places pressure on outer edges of filters to force them back against flange seat at discharge face, avoiding air leaks between flexible fiberboard filter cell and frame.

Owens-Illinois Glass Co., Toledo, Ohio.

Remote-Measuring Device

Consists of transmitter and receiver electrically connected by standard telephone circuit. Transmitter placed where measurement is taken and receiver where it is to be indicated or recorded. Any mechanical movement produced by water level, steam pressure and position which actuates transmitter through suitable linkage connected to pressure spring, float or Bourdon tube, may be measured by this "Telemco" system. Power usually not required at transmitter, and over short distances may be single-wire system. Unaffected by atmospheric changes, electrical disturbances or power supply interruption. Can be installed with several transmitters or receivers. Automatic voltage regulator in receiver holds accuracy within 1%. Supplied for indicating pressures from 10 in. water to 1,000 lb. per sq.in.

Pittsburgh Equitable Meter Co., 400 N. Lexington St., Pittsburgh, Pa.

"Telemco" units transmitter above, receiver at right

Condensate-Removing Device

Coe "Drainator" removes condensate from steam-condensing devices, heating and processing equipment, etc. No moving parts; relies for operation on thermo-dynamic properties of steam and hot water to regulate flow. Gives positive, visual indication that condensate is flowing and shows elimination. Handles entrained air with variable-capacity device. Will operate on any steam pressure up to capacity of metal parts without exchange of parts. Installed without a bypass. Is an improved design of earlier Chevalier Drainator, developed in San Francisco. Sizes from ½ to 1½ in. in range wide enough to accommodate any drainage condition. Bulletin.

Coe Mfg. Co., Painesville, Ohio.

Plastic Metallic Lead Packing

"Plastic Bestolife" is an intimate mixture of long-fiber asbestos, cotton and a finely divided metallic lead with a lubricant in such proportion that under ordinary gland pressures, a metallic lead seal is formed in pump and valve stem glands. Fine, uniform metallic lead film forms on friction surfaces to reduce friction and decrease leakage, even if shaft is corroded or worn. Metallic lead content of almost 70% forms ring with advantages of solid metal, except that plastic condition requires less pressure to keep tight. Asbestos and cotton act as binder. Two grades: No. 285 for water, acids, alkalis and salines; No. 286 for gas, oil and petroleum products.

Armite Laboratories, 1900 East 65th St., Los Angeles, Calif.

Water-Proof Insulation

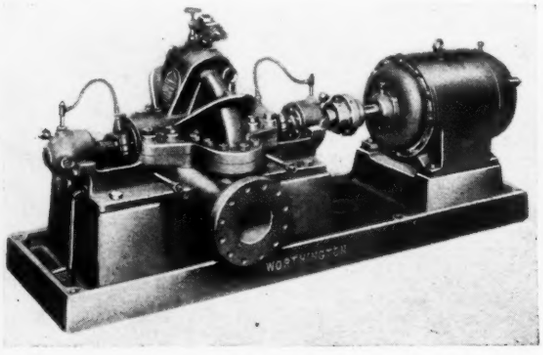
Water-proofed Capitol Rock Wool, for use where unusual moisture conditions prevail, is available in both commercial or loose and granulated forms. Has long, tough fiber, and claimed exceptionally good on cold storage work. Samples on request.

Insulation Division, Standard Lime & Stone Co., Baltimore, Md.

Centrifugal Pump

Designed particularly for refinery service, thus have heavy parts, casings capable of withstanding hydraulic pressures much over actual working pressure, and no stuffing box leakage. Extra deep water-jacketed stuffing boxes have pressure breakdown and bleed-off connections, grease sealing glands and large packing space. Steel split smothering glands smother with a stream of water any leakage which might get past stuffing box packing. Are bronze bushed to prevent sparking. Large-diameter shafts have low rotative speed. Stages arranged so that even in high-head units, pressure on any stuffing box is not more than one stage above suction pressure. Over-size, water-cooled, grease-lubricated ball bearings are operated at almost no load, because of hydraulically balanced rotor. Suitable for cold or hot liquids, either light or heavy, for operation against low or high pressure with low or high suction pressures. May be used for stabilizer feed or reflux, propane transfer and similar work.

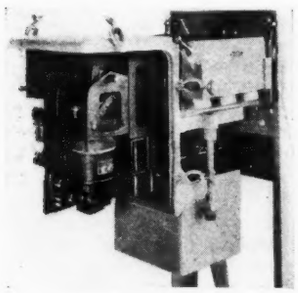
Worthington Pump & Machinery Corp., Harrison, N. J.



High-Speed Motor Operator

For application to small switchboard - type oil circuit breakers and to subway and pole-line oil switches, UC-30 high-speed motor operator consists of a universal motor directly connected through trip-free mechanism to oil circuit breaker. Closure in eight cycles. Motor suitable for operation on 110 or 220 volts, a.c., 25 or 60 cycles, and 48, 125 and 250 volts, d.c. Especially suitable for automatic throwover and automatic reclosing service. Unit illustrated applied to Condit type P-50 pole-line switch for automatic reclosing service.

Condit Electrical Mfg. Corp., Boston, Mass.

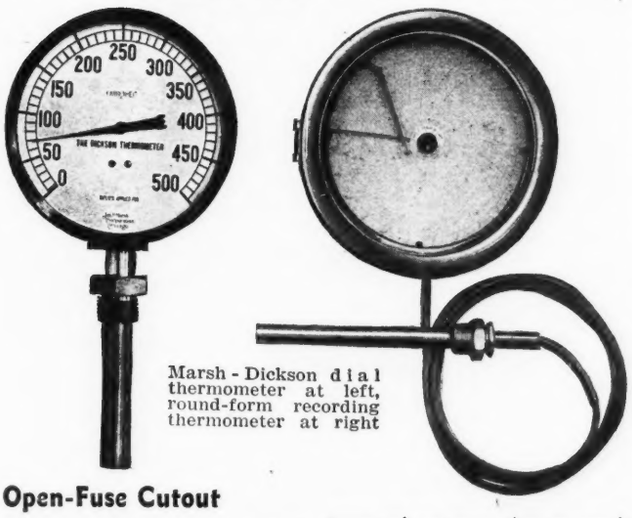


Dial and Recording Thermometers

Types 57 and 58 Marsh-Dickson dial thermometers read temperatures at point of temperature or remotely. Two types, distant reading and self-contained. Distant reading unit has flexible connecting tube between. Self-contained unit has sensitive bulb fastened directly to instrument; 5-in. dial, black-finish flanged-steel case with bayonet-type ring; 10 ft. of flexible connecting tube, bottom connected to dial instrument and with ½-in. I.P.S. bulb. Larger sizes or other finishes on special order, in both service and flush-mounted cases.

Type 59 Marsh - Dickson round-form recording thermometer made in two general types, No. 59-GF gas-filled instrument and No. 59-VT vapor tension instrument. GF is suitable for all temperature applications up to 1,000 deg. F., with a variety of chart ranges suitable for different temperature requirements. Gas-filled construction provides uniform scale. Vapor-tension instrument suitable for application to steam and hot water temperatures where operating range is not more than 30 per cent of total scale range. Instrument fitted with increasing scale chart in which graduations for a given temperature range are farther apart as temperature rises. To special order in two- or three-pen construction. GF instrument can be made in two-pen construction, one pen on temperature, other on pressure, where pressure and temperature range are approximately the same.

Jas. P. Marsh Corp., 2073 Southport Ave., Chicago, Ill.



Marsh - Dickson dial thermometer at left, round-form recording thermometer at right

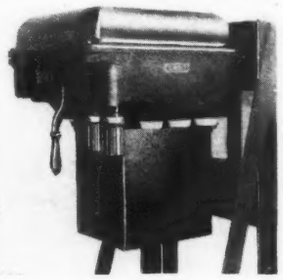
Open-Fuse Cutout

Incorporates drop-out feature which gives positive indication that fuse is blown. Two voltage ratings, 7,500/12,500Y and 15,000 volts. Both can be used from one to 60 amp. and have 1,200 amp. interrupting capacity.

General Electric Co., Schenectady, N. Y.

Industrial Type Oil Circuit Breaker

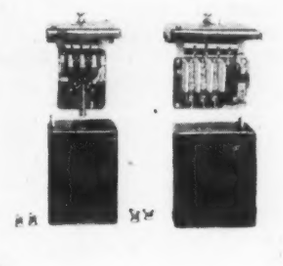
E-10 manually-operated indoor oil circuit breaker designed for protection of large motors and for general industrial service. Can be supplied full automatic or non-automatic, three-pole, single-throw for 300 amp., or less, at 2,500 volts, with interrupting capacity rating of 10,000 kva. Feature is improved copper contact structure which involves essential elements of high thermal absorption in arcing contacts, and liberal current-carrying capacity in main laminated contacts. Arcing contacts interchangeable with those of several other breakers of this company. With this type of contact it is suitable for either general purpose or motor starting. Also has provision for three series or current transformer trip coils and an undervoltage attachment, all with or without delayed action. Strong, high-speed mechanism, mechanically trip free from handle, rigid cast frame, steel-plate tank with liner and barriers between phases, arranged for flat surface mounting.



Condit Electrical Mfg. Corp., Hyde Park Station, Boston, Mass.

Oil-Immersed Magnetic Switch

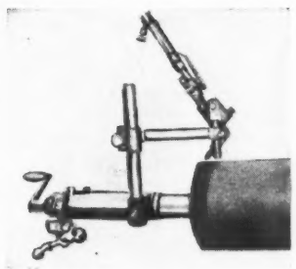
Designated as CR7006, this oil-immersed magnetic switch for use in corrosive atmospheres where Class I, Group D control is not required is designed for controlling motors that can be started at full voltage. Consists of standard magnetic switch with special coils and contact tips for operation under oil. Enclosure is square, sheet-metal oil tank with heavy boiler-plate top. Magnetic switch and special oil-immersed temperature overload relay are fastened to cover and extend into oil. Relay can be reset by means of button projecting through top cover. Three sizes for various ratings from 3 hp. at 110 volts to 50 hp. at 440 and 600 volts.



General Electric Co., Schenectady, N. Y.

Oxy-acetylene Pipe-Cutting Machine

Oxweld pipe-cutting and beveling machine consists of center rod with three spreading arms which press against pipe inner wall, holding it in position, with an arm supporting a torch that can be adjusted to desired angle to cut. Torch and arm rotate without use of crank for quick centering, and by crank when doing actual cutting. Will take almost any hand-cutting blowpipe. Readily portable. Once centered on pipe, operator merely turns crank, causing blowpipe to rotate evenly around pipe.



The Linde Air Products Co., 30 East 42nd St., New York, N. Y.

Humidity Controller

These room - type relative humidity controllers provide for various electrical circuits and come with or without humidity indicators. Actuated by hygroscopic element composed of multiple groups of human hair, a simple lever mechanism transmits motion of this element to mercury switch which operates humidifying or dehumidifying unit. Ample electrical capacity available for direct control of line - voltage solenoid water valves or small motors. With other circuit arrangements, motorized valves may be controlled, or may be used as pilot control of magnetic starter. Built for ranges from 20 to 80 per cent R.H. Will maintain total differential of 2 per cent.

Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

POWER LINES

Fuel and Energy Survey Planned by NRA

The competition in sources of energy, as between coal, petroleum and hydro industries, which has been revealed so widely and significantly in recent code hearings at NRA, will be the first job of the proposed Fuel & Energy Planning Board. Deputy Administrator W. H. Davis recently called together, under his temporary chairmanship, a committee to canvass the possibility of setting up such a board. NRA is calling together the whole group of code authorities for the 200-odd codes which are already in effect, and this meeting will be held in Washington early this month. Its job will not only be to learn about code enforcement, but to take on the job of solving inter-industry as well as intra-industry problems.

George Bach Becomes General Manager of American Fertilizer Company

Jan. 1, George Bach, formerly vice-president and general manager of Union Iron Works, Erie, Pa., became general manager and executive vice-president of American Fertilizer Co., Erie. He will continue as a member of the board of directors and will be retained in an advisory capacity by Union Iron Works. E. H. Brevillier, secretary of Union Iron Works, has been appointed general manager.

Mr. Bach, who is well-known throughout the boiler manufacturing industry, is past-president of American Boiler Manufacturers Assn., a member of the executive committee of the National Board of Boiler & Pressure Vessel Inspectors and a member of the Pennsylvania Boiler Advisory Board. He has been in power plant work and the boiler business for about thirty-five years.

Coleman and Feiker Head American Engineering Council

With renewed pledge of support from its members, American Engineering Council elected new leaders at its annual meeting in Washington Jan. 11, 12 and 13. John F. Coleman, consulting engineer of New Orleans and past president of the A.S.C.E., was elected president, and Frederick M. Feiker was elected executive secretary, succeeding Lawrence W. Wallace, who retires to become vice-president in charge of the Washington office of W. S. Lee Engineering Corp.

Policies of the Roosevelt administration were the principal topics of discussion at the meeting. Concerning the allotment of federal funds to finance municipal waterworks, electric light and power plants which duplicate or destructively compete with existing plants, a committee was appointed with Coleman as chairman to draft a letter to President Roosevelt suggesting that a public announcement that loans will not be made for unnecessary competitive services would restore confidence of the investing public in the stability of their public utility investments and would result in a considerable increase in employment and in the purchase of materials for extensions and additions to existing privately owned and operated services.

$220,000 Saving Made in Navy Yard Power

The annual report of the Chief of the Bureau of Yards and Docks to the Secretary of the Navy for the fiscal year, 1933, shows that gross power savings for the year were $220,866. The total cost of power for 1933 at industrial navy yards, including Washington, was $2,647,938 as compared with a total cost of $2,802,615 in 1932, and $2,936,466 in 1931. On the basis of average unit cost in 1932, the gross saving in 1933, after correcting for quantity of power distributed and for temperature, is $220,806. Eliminating repairs, which cost $92,170 more, and fuel, which cost $73,905 less, than in 1932, the saving in routine operating expense is $239,131. Steam generated was 4,000,807 lb., at a cost of $0.334 per thousand pounds.

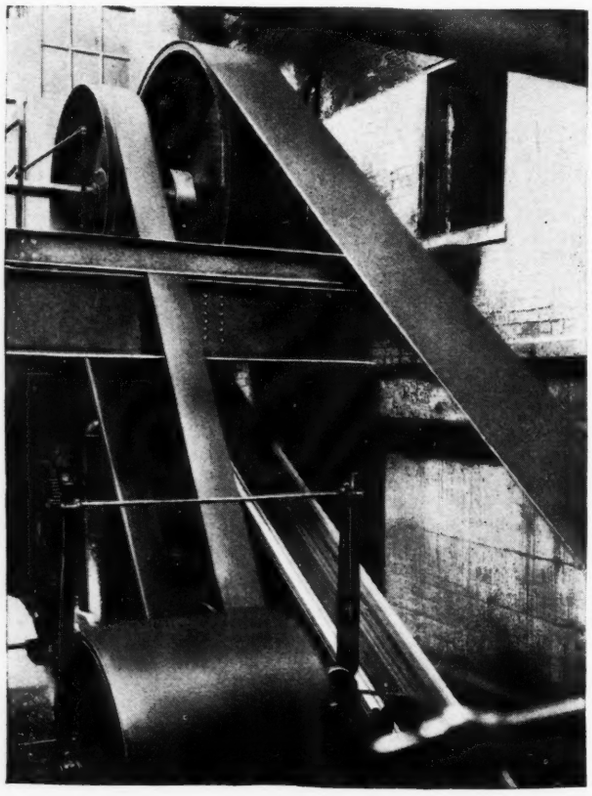
78,274,431 kw.-hr. of electricity were distributed at a cost of $0.01180 per kw.-hr., and 7,735,078 cu.ft of compressed air at a cost per thousand cubic feet of $0.0385. Savings for the year are attributed to careful control and interest taken in the matter of economical production and distribution of power, and to operation of the Economy Act.

New turbine-generators were purchased for the navy yards at Boston, New York and Puget Sound to replace smaller units. A contract was awarded for four 10,000-sq.ft. boilers for the navy yard at Mare Island, and three 5,000-sq.ft. boilers were installed at the Marine Corps base in San Diego. Work at this latter station also included new steam distribution lines and a steam tunnel. Two air compressors were repaired at the New York navy yard, and a new 3,500-cu.ft. per min. air compressor and circulating pump purchased to replace worn-out units at Portsmouth navy yard. Several other minor replacements were made.

Two New Power Plants for W. Va. Coal Mines

Typical of several power plants which are being planned by operators in the West Virginia-Virginia coal fields is the 2,500-kw. installation recently put into service by Jewell Ridge Coal Co., at Richlands, Tazewell County, Va., on the Clinch River. This is the second power plant to be constructed in the territory recently, the first being a 1,500-kw. steam plant at Lillybrook, Raleigh County, W. Va., for Lillybrook Coal Co.

The Jewell Ridge plant produced 312,000 kw.-hr. the first month of operation. The plant cost $122,000, and a 7-mi. transmission line with accessories cost $18,000. The plant uses picking-table refuse and "bone,"



Last big water-wheel drive in the Miami Valley paper manufacturing district

This drive transmits entire power requirements for Wrenn Paper Co., Middletown, Ohio. This drive has been operated 24 hr. per day since May 15, 1933, without stopping. The belt is 87½ ft. long, open end 28 in. wide x 8-ply. Driving pulley is 60 in. in diameter, driven pulley 108 in. in diameter, belt speed 3,100 ft. per min. Average hp. is 175, with intermittent overload of 50%.

Photo courtesy The B. F. Goodrich Co.

2.6 lb. of such fuel being required per kw.-hr. the first month. The prospects are that the coal rate will be considerably reduced. Although without market value, this fuel is billed to the power division of the coal company at $1 per ton. Central-station power (Appalachian Electric Power Co.) has been averaging $0.0172 per kw.hr., including demand and power-factor charges. The plant is equipped with automatic control of feed water, stoker draft and induced chimney draft. E. R. Feicht, of Bala-Cynwyd, Philadelphia suburb, was consulting and designing engineer.

Steam is generated at 250 lb. pressure with 150 deg. F. superheat and supplied to two 1,250-kw. condensing turbo-generators. Guaranteed performance is one kw.-hr. per 13.25 lb. of steam. Surface condensers maintain a 28-in. vacuum.

A 13,200-volt line connects to five banks of new distribution transformers which supply 2,300-volt power to previously-constructed synchronous motor-generator substations, a part of the mine equipment when central-station power was employed. The motors are operated with a slightly leading power factor, which makes for virtual unity power factory on the entire system.

Canada Installs 270,210 hp. in New Water Power Plants

The Dominion Water Power and Hydrometric Bureau of the Department of the Interior of Canada has issued its annual review of hydro-electric and water-power development throughout the Dominion during 1933. The review discloses that while no large water-power undertakings were begun in 1933, installations were completed and brought into operation amounting to 270,210 hp., so that the total of water-power developments installed in Canada at the end of 1933 is 7,332,070 hp. There has been an encouraging recovery in power demand. Dominion Bureau figures indicate a substantial increase over 1932 figures for the months from May to October. Figures for November and December are not yet available, but it is anticipated that the total production will not be much short of 1930, the highest year on record. Copies of the bulletin may be obtained free on application to the Director of the Dominion Water Power and Hydrometric Bureau, Ottawa, Canada.

Smoke Abatement Shows Progress

Three years ago New Yorkers had good reason to complain of the dense black smoke that blew across the Hudson River from New Jersey; but not today. For now, after three years war on smoke in the Hudson County area, Smoke Abatement Engineer William G. Christy of the Hudson County Smoke Department, reports in his Annual Report to the Board of Freeholders "a reduction of 90 per cent in smoke violations on all classes of fuel burners. This," Christy estimates, "amounts to about 85 per cent actual reduction in smoke density over the 3-year period."

"I lay this improvement chiefly to the fact that fuel users are sold to the idea that they save fuel in proportion to the smoke they abate; and have found in practice that it is true. I find it necessary to take court action against only those who 'have no time' to abate smoke."

"17,049 observations were taken of industrial plants in 1933. Of this number there were only 396 violations; a reduction since May, 1931, of 91 per cent in violations."

A city-wide smoke abatement program in Chicago which will give employment to 500 CWA workers has been developed. Men will be assigned to offices in each ward of the city. Of the 500 workers who started to work on Jan. 11, 450 were mechanical engineers with technical knowledge of combustion and of fuel-burning equipment.

Frank E. Trumble, chief smoke inspector of Buffalo, and Frank A. Chambers, chief smoke inspector of Chicago, president and secretary respectively of the Smoke Prevention Association, announce June 19-22 as the dates of the 28th Annual Convention. The Hotel Statler, Buffalo, has been selected as convention headquarters.

Prof. Donald B. Keyes of the University of Illinois will address the Society of Chemical Industry Feb. 17 on "Cooperative Studies on Sulphur-Dioxide Removal from Flue Gases." This regular meeting of the American Section of this society, will be held at The Chemists' Club, 52 East 41st St., New York City.

MEETINGS

American Institute of Mining and Metallurgical Engineers, in its 143rd meeting at the Engineering Societies Bldg., 29 West 39th St., New York, N. Y., Feb. 19-22, will include several papers of interest to power engineers. These include a series on waste-heat boilers in refineries, "Oxidation of Coal and Its Relation to the Analysis of Coal," by E. Stansfield, W. A Lang, and K. C. Gilbart, "Mineral Matter in Coal: A Preliminary Report," by A. W. Gauger, E. P. Barrett and F. J. Williams, "Classification of Coals of the United States According to Fixed Carbon and B.t.u.," by W. A. Selvig, W. H. Ode and A. C. Fieldner, "Application of Coal Classification to the Problems of Commercial Sales Agencies and Operation of Codes," by H. N. Eavenson, "Anthracites and Semi-anthracites of Pennsylvania," by H. G. Turner, "Estimation of the Grindability of Coal," by H. P. Yancey, O. L. Furse and R. A. Blackburn, "The Economic Effect of the Petroleum Code," by H. J. Struth, "The Corrosion Problem," by Dr. F. N. Speller, "Aluminum Copper and Alloy Conductors, A Discussion."

Third International Heating & Ventilating Exposition will be held during the week of Feb. 5-9, Grand Central Palace, New York, N. Y., as announced in previous numbers of *Power,* in connection with the annual meeting of the **American Society of Heating & Ventilating Engineers.** Previous expositions were held in Philadelphia and Cleveland in 1930 and 1932. Included in products shown will be combustion apparatus, hydraulic apparatus, steam heating equipment, ventilating and air conditioning apparatus, control appliances, refrigerating equipment, district heating materials, electrical equipment and specialties. More than 57,000 visitors are expected at the exposition.

National District Heating Association will hold its 25th annual convention in Rochester, N. Y., from June 12-15.

American Society for Testing Materials will hold its 1934 annual meeting in Atlantic City from June 25 to 29, with Chalfonte-Haddon Hall as its headquarters.

OBITUARIES

Louis Blackstone Nutting, 63, president of the Foster Wheeler Corp., New York, N. Y., died Jan. 12. He had been ill for several weeks. Mr. Nutting joined Henry R. Worthington, prominent pump builder, in 1893 and remained there for three years. In 1897 he became special representative of Mr. Worthington in the Hawaiian Islands. He left Worthington in 1900 to join R. D. Wood & Co. and in 1903 became general sales manager and director of the Power Specialty Co. when it was organized. He later became its secretary and finally president.

During the World War, Mr. Nutting developed a standardized water-tube boiler for cargo vessels that could be manufactured in any boiler shop, and a number were installed in government vessels. Foster Marine Boiler Corp. was formed at the end of the war to take over construction of water-tube boilers from these designs and Mr. Nutting was made president and director, which position he held until the corporation was merged with Foster Wheeler Corp. in 1930. In 1920, Mr. Nutting had become a director of Wheeler Condenser & Engineering Co. and it was largely through his efforts that a consolidation was formed between Power Specialty Co. and Wheeler Condenser & Engineering Co.

When Foster Wheeler Corp. was thus formed, Mr. Nutting became president and director and held both of these positions until his death. He was also active in several other affiliated engineering organizations, including Canadian

Power Specialty Co., Ltd. and the Destructor Co. The first-mentioned became Foster Wheeler, Ltd. in 1928. He also was largely responsible for the subsidiary companies, Foster Wheeler, Ltd. of London and Societe Anonyme Foster Wheeler of Paris, incorporated in 1929.

A. Burton Chamberlain, 58, assistant superintendent of the station engineering department, Edison Electric Illuminating Co. of Boston, died there Jan. 22. He had been employed by the company for the past 30 years, chiefly in engineering capacities.

Everett Morse, president of Simplex Wire & Cable Co., Cambridge, Mass. since 1903, died in Boston Dec. 27 after a short illness. He was widely known in power engineering circles and had been prominently identified with recent development of Massachusetts Institute of Technology. He was also a director of Arthur D. Little, Inc., the Sierra Pacific Power Co., Runford Chemical Works and others.

Joseph S. Oechsle, 39, a consulting engineer of Worthington Pump & Machinery Corp., died in Philadelphia, Dec. 24. He was one of the founders and subsequently president of Metalweld Inc., Philadelphia, manufacturer of portable air compressors, before that company was consolidated with Worthington in 1931.

POWER NOTES

John A. Walls has been elected president of Pennsylvania Water & Power Co., and of Safe Harbor Water Power Corp., to fill the vacancy caused by the death of Charles E. F. Clarke. J. E. Aldred is chairman of the board of both companies. Mr. Walls has been vice-president and chief engineer of Pennsylvania Water & Power Co. since 1914, and of the Safe Harbor Co. since its organization. He has been continuously associated with the developments of the water power of the Susquehanna basin at Holtwood and Safe Harbor.

J. L. Rintoul, who has been treasurer of Pennsylvania Water & Power, and F. A. Allner, general superintendent, have been elected vice-presidents, and a number of other changes have been made in the organization.

Roy E. Hoffmann, formerly manager of diesel engine sales for Fairbanks-Morse Co. in Atlanta, Ga., has taken charge of sales of Superior diesel engines and natural gas engines in the southeastern territory, with headquarters at Jacksonville, Fla.

Lawrence W. Wallace, executive secretary of American Engineering Council for the past 13 years, has become vice-president in charge of the Washington office of W. S. Lee Engineering Corp., and the offices have been moved from 744 Jackson Place to the Woodward Bldg., 15th and H Sts. N. W., Washington, D. C.

J. B. Durkee has been appointed manager of the Houston, Texas, office of A. M. Byers Co., Pittsburgh.

S. M. D. Clapper has been elected president of General Refractories Co., succeeding John R. Sproul, resigned. Mr. Clapper had been chairman of the board which post is now vacated. Mr. Sproul also resigned as a director and has been appointed assistant to the president.

Warren F. Loomis, purchasing agent of Stone & Webster, with headquarters at Boston from 1917 to 1933, has been appointed superintendent of purchases for the city of Boston by Mayor Mansfield. He will have complete charge of purchasing for the municipality.

Hugh L. Rusch, with Northern Pump Co., Minneapolis, Minn., for 1½ years, has been elected vice-president and Eastern sales manager.

General Regulator Corp., 50 Church St., New York, has elected the following officers: C. J. King, president; R. A. Wright, vice-president; F. H. Plum, vice-president and secretary. The above officers were formerly president, sales manager and vice-president, respectively of Smoot Engineering Corp. J. W. Ackley is treasurer. General Regulator Corp. will soon place on the market a line of regulating equipment featuring a new stabilizing principle.

National Association of Fan Manufacturers has opened an office at 5-208 General Motors Bldg., Detroit, Mich., to co-ordinate its activities under the National Recovery Act. The Association has been in existence continuously since 1918. The new office will be in charge of L. O. Monroe.

Ambler Asbestos Shingle & Sheathing Co. has been merged with **Keasbey & Mattison Co.,** both of Ambler, Pa., and **Turner & Newall, Ltd.,** of Great Britain, has acquired controlling interest in the merged company. Keasbey & Mattison, established in 1873, has been for more than sixty years one of the country's principal manufacturers of magnesia and asbestos products. The enlarged business will retain the name of Keasbey & Mattison Co., and A. S. Blagden will continue as president.

H. O. Swoboda, Inc., has moved and combined office and laboratory at 4301-3 Main St., Pittsburgh, Pa.

A course in metal radiography will be conducted at the laboratory of St. John X-Ray Service, Inc., 30-20 Thomson Ave., L. I. City, N. Y., beginning Feb. 5, 1934, twice weekly for eight weeks.

Richmond Seabury, 1 Orchard St., Wellesley Hills, Mass. has been appointed sales representative of Jas. P. Marsh Corp., 2073 Southport Ave., Chicago, Ill.

Connersville Blower Co., Inc., Connersville, Ind., has changed its name to Roots-Connersville Blower Corp. No change has been made in officers.

W. S. Barstow & Co., Inc., has changed its name to E. M. Gilbert Engineering Corp., to identify the organization with its president, E. M. Gilbert Headquarters will remain at 412 Washington St., Reading, Pa.

STRAWS

Pointing the way the business wind blows

Chicago, Ill., is having plans drawn for a municipal pumping plant on Sebor St., for water system, 62x192 ft., estimated to cost over $750,000 with pumping machinery and accessories. Paul Gerhardt, Jr., 64 West Randolph St., architect.

Minot, N. D., is considering a proposal of Montana-Dakota Power Co., Mineapolis, Min., for construction of welded steel pipe line from Williston, N. D., for natural gas service. Proposed line with compressor and booster stations is estimated to cost $1,523,000. Proposition provides for municipality to arrange for Federal loan in such amount to provide for early installation, with company to guarantee payment of principal and interest over a term of months. J. E. McKoane is chairman of committee appointed to investigate proposal and project.

Lorain, Ohio, has authorized plans for a $1,500,000 municipal electric light and power plant and will arrange for financing in that amount through Federal aid at early date. H. F. Harmount, 2417 Oak Park Ave., Cleveland, Ohio, consulting engineer, has been engaged to supervise the project, and bids for equipment will be asked through that office.

Bakersfield, Calif., is projecting plans for a new municipal generating plant for service for municipal buildings, street lighting and other city work. Fred W. Nighbert, city manager, has been directed to secure information and estimates of cost, preferably for a diesel engine-generating unit and complete accessories.

Schmidt Brewing Co., Wilkins St., Detroit, Mich., will build new boiler plant in connection with new brewing unit and modernization of present plant. About $500,000 will be expended. G. A. Mueller, 1346 Broadway, engineer.

Plans are maturing for construction of a geothermal steam turbine electric generating station at a place known as the "Geysers," in Sonoma County, Calif., about 15 miles from Healdsburg, Calif., by Geysers Development Co., 417 South Hill St., Los Angeles. Proposed plant will be used for central station service in this district, and high-tension transmission line will be built to Healdsburg and other nearby communities. Program is estimated to cost $250,000, and arrangements are being made for financing in that amount through Federal aid. C. Lee Straub, Mosswood Rd., Berkeley, Calif., is engineer in charge.

Hastings, Neb., has arranged for Federal grant and loan for $140,000 for extensions and improvements in municipal electric light and power plant, including installation of new generating and auxiliary equipment, 25-ton overhead traveling crane and other apparatus. Proposed to begin program soon. Black & Veatch, Mutual Building, Kansas City, Mo., are consulting engineers.

Muskogee, Okla., will vote on a municipal power project in April, when a proposition for bond issue of $1,260,000 will be placed before citizens. It is proposed to construct a large diesel engine-generating station, with power and distributing lines. Financing through Federal grant and loan. Burns & McDonnell Engineering Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.

Burlington, Kans., has completed financing through Federal aid for $118,000, of which $85,000 will be used for construction of new municipal electric light and power plant, and $33,000 for an electric distribution system. Program is scheduled to begin at early date. E. T. Archer & Co., New England Bldg., Kansas City, Mo., consulting engineers.

Division of Purchase, Sales & Traffic, Department of Agriculture, Washington, D. C., is asking bids until Feb. 14 for new boiler plant and cold storage laboratory at Bureau of Plant Industry, Beltsville, Md. (Proposal 5700.)

LaGrande, Ore., plans a municipal hydro-electric generating plant in connection with a pipeline project for increased water supply for municipal service. The pipe line will be about 16 mi. long. A fund of $193,704 is being arranged for program through Federal aid. A. H. McLain, city engineer, and H. K. Knapp, water superintendent, in charge.

Sandusky, Ohio, has engaged Froehlich & Emery, Second National Bank Bldg., Toledo, Ohio, consulting engineers, to prepare plans for new municipal electric light and power plant to cost $1,400,000, with equipment, in which amount bonds were recently authorized by citizens. Federal financing is under way. Bids scheduled to be asked at early date.

St. Paul, Minn., will vote on a municipal power project at regular city primary election, March 6, when a proposition to issue bonds for $10,230,000, will be on the ballot. It is estimated that the proposed station will provide about 40 per cent of the city demand for light and power, the remaining 60 per cent to be furnished by Northern States Power Co., which has been supplying local service, including gas and central steam heating facilities. If approved, Federal aid will be solicited. George M. Shepard, city engineer, in charge.

Sonoma Valley Brewing Corp., Exchange Bank Bldg., Santa Rosa, Calif., will install boiler plant in new brewery on College Ave. It is proposed to ask bids in February. Entire project will cost about $160,000.

Henry County, Va., manufacturers are planning to take over the Pinnacles hydro-electric project in case voters of Danville, Va., reject a $3,000,000 government loan.

Bureau of Yards & Docks, Navy Department, has awarded a contract for $8,995 to Carrier Engineering Co., Philadelphia, for air conditioning Building No. 7 at the Navy Yard there.

Construction of a large hydro-electric plant in connection with the Taballo dam and water storage reservoir, which is to be constructed on the Rio Grande in New Mexico at a point between the Elephant Butte dam and El Paso, is proposed by the Water Users Association of Rio Grande Valley. Assurances have been received by promoters of the project from mine owners and industrial concerns over a large area in New Mexico and El Paso that they would enter into contracts to use such power. Capacity of 50,000 hp. is tentatively proposed.

Middlesboro, Ky., is planning a $328,000 city-owned diesel-engine generating plant.

Menominee Falls (Wis.) Distilling Co. is planning a $185,000 expansion.

Northwest Distilleries Corp., Seattle, Wash., is planning a $200,000 expansion.

Lexington, Miss., plans a $100,000 city power plant.

Delta, Colo., is arranging financing for a city-owned light and power plant to cost $150,000.

Molaska Products Corp., Elizabeth, N. J., will install motors, pumping equipment, etc., in its molasses plant at Elizabeth. Cost will run around $150,000.

Iowa City, Iowa, has authorized plans for a city-owned electric light and power plant to cost $800,000. Federal aid will be sought.

Two Rivers, Wis., has applied for a federal loan of $250,000 for a city-owned electric light and power plant.

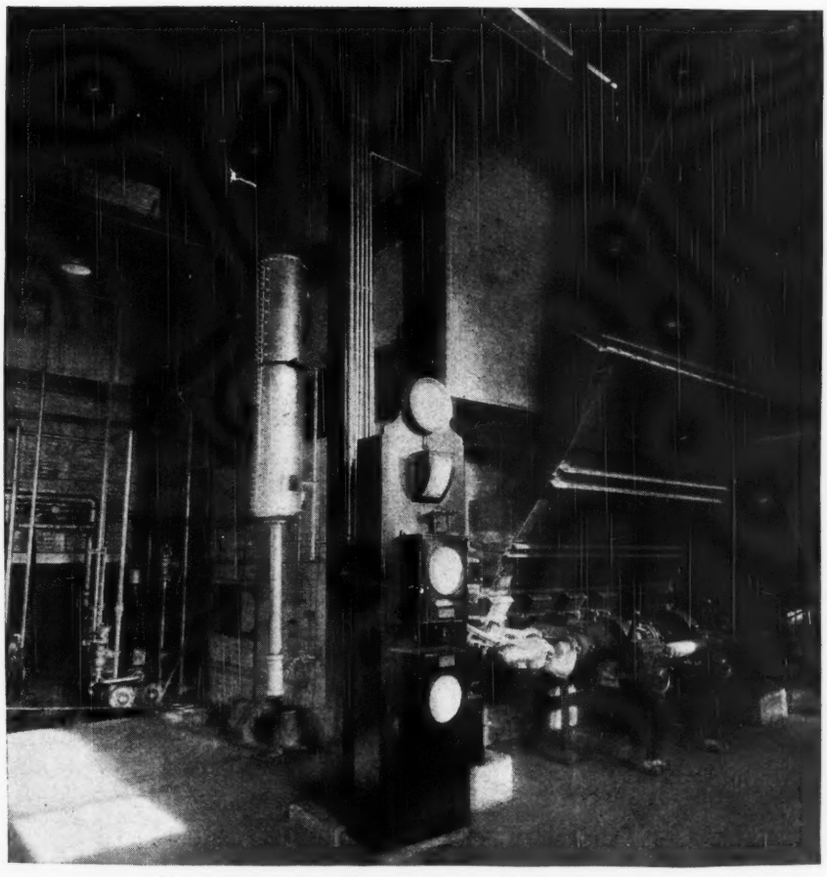
Old South Brewing Co., Winston-Salem, N. C., will build at Statesville, N. C., at a cost of $115,000.

Norman, Okla., plans a city light and power plant to cost $600,000. Federal aid will be sought.

Owings Mills Distilling Co., Owings Mills, Md., is planning a $100,000 expansion.

Center Moriches Ice & Cold Storage Co., Long Island, N. Y., has ordered a diesel from McIntosh & Seymour Corp. for refrigerating compressor drive.

Onawa, Iowa, has authorized improvements to cost $50,000 in its municipal light and power plant. These improvements will include a changeover from steam to diesel power. Nixon & Reynolds, Omaha, Neb., are engineers.



New Steam Generating Unit for Ohio Roofing Plant

Logan-Long Co., Franklin, Ohio, has completed the first step in its modernization program by adding this steam generator, designed for 300 lb. working pressure, but operating temporarily on the old pressure of 150 lb. Space is left for a convection type superheater to give 150 deg. superheat when other new units are added later; pressure will then be stepped up to 275 lb. The 5,900-sq.ft. Foster-Wheeler 4-drum, bent-tube boiler is fired by an underfeed stoker. It has a water-cooled bridge wall, and the front drum is the submerged type.

Sidney, Neb., is considering purchase of a diesel engine power plant, dependent on outcome of negotiations for lower rates.

Quincy Stove Co., Quincy, Ill., has installed a Nordberg diesel engine to drive its plant.

Marion, Va., has had a study made by J. B. McCrary Co., Atlanta, Ga., of the possibilities of a local light and power plant. Construction of a diesel generator set and distribution system to cost $152,000 has been recommended. An alternative proposition made by Galax, Va., is that Marion purchase its power from the proposed hydro-electric plant that Galax is planning to build in the New River.

Auburn, N. Y., has plans for a city-owned electric light and power plant and electrical distributing system to cost $310,000.

Hiawatha Brewing Co., Minneapolis, Minn., is planning a $175,000 addition.

Forsyth, Mont., is planning a $135,000 city-owned electric light and power plant.

San Angelo, Texas, has plans for a municipal plant using diesel-engine generators. A fund of $880,000 is being arranged.

Western Brewing Co., Seattle, Wash., is planning to construct a $200,000 plant.

Lorain, Ohio, will soon take bids for a $1,500,000 city-owned power plant.

Chinner Ausmann Brewing Co., Long Beach, Calif., will build $160,000 plant.

Salem, Ohio, is planning purchase of second-hand diesel engine or uniflow engine units.

Several municipalities in Kansas are arranging for early construction of municipal electric light and power plants. Osawatomie is securing a fund of $166,300 for municipal generating station, using diesel engine-generating units, with portion of appropriation for new municipal waterworks, Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., is consulting engineer. Strong City proposes a municipal light and power station, with diesel engine-generator units, to cost about $53,000, and has made application for Federal grant and loan in that sum. E. T. Archer & Co., New England Bldg., Kansas City, Mo., are consulting engineers. Russell plans extensions and improvements in present municipal power plant, with installation of new oil engine-generator unit and accessories, estimated to cost $67,500, to be secured through Federal aid. Anthony proposes extensions and betterments in municipal power plant, to cost $91,625, with equipment, and has made application for Federal grant and loan. Black & Veatch, Mutual Bldg., Kansas City, Mo., are consulting engineers. Augusta plans installation of new equipment in municipal power station, estimated to cost about $20,000. McPherson is securing Federal grant and loan for $210,530 for a new electric light and power plant, using diesel engine-generating units, for which plans have been completed by Burns & McDonnell Engrg. Co., Kansas City, Mo. Glasco is completing surveys and estimates of cost for a new municipal power station. Independence plans electrification of waterworks pumping plant, with installation of new oil engine-generator unit and accessories, three high-duty centrifugal pumps and auxiliary equipment. Glen Hackmaster, city engineer, in charge, now arranging fund of $60,000.

Columbia Railway & Navigation Co., Columbia, S. C., a subsidiary of International Paper & Power Co., New York, N. Y., is planning construction of a large hydro-electric generating plant on the Santee and Cooper Rivers, vicinity of Pinopolis, in southern part of State. Development will be carried out in connection with a navigation program on both rivers noted, including a deep water navigable channel from Charleston to Columbia. Power plant will have an ultimate capacity of 200,000 hp. Estimated to cost $34,000,000, and application has been made for Federal aid in that sum, of which about $10,000,000 is requested as a grant and the remainder as a loan. T. C. Williams is president.

Coeur d'Alene, Idaho, has approved a bond issue of $600,000 for construction of a new municipal electric light and power plant, and waterworks. Plans for project will be placed under way at once. Arrangements are being made for Federal financing in amount noted.

A. A. Wynne, of Pecos, N. M., has been granted a franchise to supply electric power and light to the city of Pecos and surrounding country, by the San Miguel County Board of Commissioners.

FEDERAL ALLOTMENTS

To	For	Loan and/or Grant	Total, Thousand Dollars
Power Plants, etc.			
Nat'l. Pks., Bldg. & Resev.,	Elev., Heating	G	90.8
Columbia City, Ind.	1,000-kw. Turb.-Gen.	G	29
Hartford, Wis.	3,000-sq.ft. blr., 700-kw. Turb.-Gen.	L & G	40
Moberly, Mo.	Two 2,360-sq.ft. blrs., two 2,000-kw. Tur.-Gen.	L & G	700
Great Bend, Kans.	Htg. Plt., Ldry., Pumps,	L & G	36
Anthony, Kans.	750-kw. turb.-gen.	G	15
Augusta, Kans.	280-hp. diesel-Alt.	G	6
Minden, Neb.	Diesel-Generator Unit	G	8
Consol. Schl. Dist. 2, Gower, Mo.	Htg. plt. etc.	L & G	4.5
Allegheny Gen'l. Hosp., Pittsburgh	Finish Pwr. Hse., etc.	L	2,000
Pawnee, Okla	Two 300-kw. Diesel-Gen., etc.	L & G	60
State Tchrs. Col., Fredericksburg, Va.	Blr., Bldgs.	L & G	360
Alexandria, La.	New Blr & plt. repair	L & G	250
Yuba County, Calif.	Ldry., Pwr. Plt., Bldgs. (Marysville)	L & G	75
Hydro-Electric			
Augusta, Ga.	Hydro-electric	L & G	1,250
Sequin, Tex.	Raise Dam, Watrwk. Driving Wheel, etc.	L & G	130
Bur. Recl., Dept. Int.	Indus. Surv. Boulder Dam	G	25
San Francisco, Calif.	Raise O'Shaughnessy Dam	L & G	3,500
Metro. Wtr. Dist. /So. Calif.	Los Angeles Parker Dam	L & G	2,000
Beaver, Neb.	Ice-making Equip't.	L & G	8
Gulfport, Miss.	Cold-Storage Warehse., Wharf, etc.	L & G	1,150
Waterworks & Pumps			
Great Barrington Fire Dist., Mass.	Waterwks. Imp.	L & G	74
Georgetown, Mass.	Pumping Plant	L & G	130
North Hempstead, N. Y.	Sewage Disposal	L & G	125
Plandome, N. Y.	Waterwks. Imp.	L & G	70
Cauyga, N. Y	Waterworks	L & G	38
Irvington, N. Y.	Waterwks. Imp.	L & G	42
West Kittaning, Pa	Wells, Pumps	L & G	58
Hartwell Dr. Dist., Green Co., Ill.	Drainage	L & G	83
McLean, Ill.	Waterworks	L & G	45
Van Buren, Ind.	Waterwks. Imp.	L & G	12
Carlisle, Ohio	Well & Pumps	L & G	13
Upper Arlington, Ohio	3 Wells, Pumps	L & G	140
McArthur, Ohio	2 Wells, Pumps	L & G	66
Zeeland, Mich.	Move & Rep. Pumps	L & G	2
East Lansing, Mich.	Waterworks Imp.	L & G	50
Arlington Hts., Ill.	Well and Pumps	L & G	50
Wahoo, Neb.	Waterworks, Imp.	G	19
Catlin, Ill.	2 Wells, Pumps	L & G	45
Hardington, Neb.	Sewage Disp.	L & G	21
Quinter, Kans.	Well, Pumps	L & G	17
Blooming Prairie, Minn.	Waterwks. Pump.	L & G	14
Washington, Kans.	Rep. Dam, Pumps	L & G	20
Kahoka, Mo.	Well and Pumps	L & G	35
Louisville, Neb.	Well and Pumps	L & G	9
Ely, Minn.	Waterworks Imp.	L & G	74
Chamberlain, S. D.	Filtration Plt.	L & G	33
Cottonwood Falls, Kans.	Well and Pump	L & G	4
Oconto, Neb.	Well and Pumps	L & G	12
Logan, Kans.	Well and Pumps	L & G	3
Metrop. Sewage Comm., Milwaukee	Sewer and Pumps	L & G	120
Hoffman, Minn.	Well and Pumps	L & G	15
Harmony, Minn.	Well and Pumps	G	1
Cologne, Minn.	Well and Pumps	L & G	14
Ashland City, Tenn.	Waterworks	L & G	39
Carolina Beach, N. C.	Waterworks Imp.	L & G	50
Hampton, S. C.	Waterworks Imp.	L & G	40
Moorefield, W. Va	Waterworks	L & G	50
Sardis, Miss.	Waterworks Imp.	L & G	21
Heflin, Ala.	Waterworks	L & G	34
Sulligant, Ala.	Waterworks	L & G	74
Houlka Consol. Schl. Dist., Mo.	Well & Pump	L & G	32.4
DeSarc, Ark.,	Waterworks	L & G	41
Victoria, Ark.	Wells & Pumps	L & G	41.5
Junction City, Ark.	Well and Pumps	L & G	39.5
Globe, Ariz.	Waterworks Imp.	L & G	68
Rockwall, Tex.	Well & Pumps	L & G	35
Poteet, Tex.	Waterworks Imp.	L & G	12
Cooper, Tex.	Pumps & Imp.	L & G	30
Hearne, Tex.	Waterworks Imp.	L & G	25
Bridgeport, Tex.	Waterworks	L & G	145
Richland Springs, Tex.	Waterworks	L & G	30
Soudan, Tex.	Deep well, Pump	L & G	9
Austin, Tex.	Waterworks Imp.	L & G	13
Grand Saline, Tex.	Waterworks Imp.	L & G	45
Port Lavaca, Tex.	2 Wells, Pumps	L & G	54
Canadian, Tex.	Waterwks, Pump	L & G	31
Nederland Utilities Corp., Tex.	Waterworks Imp.	L	8
Modesto, Calif.	Sewers	G	2
Whittier, Calif	Waterworks Imp.	L & G	4
Morgan Hill, Calif.	Waterworks Imp.	L & G	49
Lompoc, Calif.	Waterworks Imp.	G	5
Cambria, Calif.	Waterworks	L & G	24
Total			**$14,242,700**

MOTORBOAT SHOW FEATURES DIESELS

(Continued from page 85)

conventional air cylinders for starting, this engine is started just as a gasoline engine is—by means of twin 24- or 32-volt starters, and a generator is provided to charge the starting battery.

Lubrication is by a force-feed system, each disk carrying a lubricating spray unit directly ahead of each slipper. Pistons are supplied with oil metered and under pressure. The three simple main bearings of the drive shaft are directly lubricated by force-feed outlets.

For the present, the engine will be built in four cylinder sizes, 3½x4¾, which develops 125 hp. at 1,800 r.p.m.; 5-in. bore developing 300 hp. at 1,500 r.p.m.; 6-in., developing 500 hp. at 1,500 r.p.m.; and 7-in., developing 625 hp. at 1,200 r.p.m. An engine of the smallest size has been operating under test since last June.

Three engines of this type were exhibited at the Motor Boat Show last week in New York. The unit illustrated runs at 1,800 r.p.m., to develop 145 hp., (intermittent duty), and has a bore of 3½ in. and a stroke of 4¾ in. The second was a reduction gear model incorporating a 3-1 reduction gear, the third a direct-driven engine-generator set, with an 80-kw. GE generator running at 1,750 r.p.m. It is 72 in. long, 22 in. wide and 29 in. high.

Diesel engines formed a more impressive part of the 29th annual national motorboat show than they ever have before. In addition to the Sterling engine, a number of other new designs were shown. Atlas Imperial Diesel Engine Co., which has always been conservative in the matter of speed, showed a 90-hp., 4-cycle, 4-cyl. 6x8-in. engine running at a speed of 1,000 r.p.m. and weighing 5,000 lb. The fuel injection has been revised and a distributor is now used instead of a mechanically operated valve in each cylinder. The distributor is supplied with fuel from a constant pressure "rail," but fuel is metered for each cylinder by the same valves, thus insuring the same quantity of fuel being supplied to each cylinder in turn. The engine is an open combustion chamber type with fuel consumption from 0.40 to 0.43 lb. per b.hp.-hr. Full-pressure lubrication is used. Starting is by compressed air. Smaller size units are being contemplated, experimental work having been completed on a 40-hp. unit.

Bolinders Co., Inc., showed the first of a new line of light-weight engines which have weights as low as 33 lb. per b.hp. They are available in three sizes, 1, 2 and 4 cyl., 25 hp. per cyl., 7⅛x7⅛-in., with normal speed at 800 r.p.m. and maximum, 1,000. They are all 2-cycle units with cast-iron box section bedplate, with silencer for scavenging air built in. A variable-speed governor on the side of the engine, driven by a vertical shaft, allows the operator to control speed at will from approximately 100 r.p.m. to maximum speed. It is also arranged for remote control.

Buda Co. exhibited a compressorless, solid injection, 6-cyl., 4-cycle, high-speed, light-weight, full diesel, 4x5½ in., developing 65 hp. at 1,600 r.p.m. (constant speed) and 85 hp. at 2,000 r.p.m. for intermittent service. Combustion chambers in the head are the latest M.A.N. type with "after chamber" to better combustion. A specially designed "shock absorber" cylinder head is also used.

Cooper-Bessemer Corp. showed two small marine diesels: Type BN, 5½x7¾-in. in 3, 4, 6 and 8 cyl., rated 15 to 25 hp. per cyl. depending upon speed, which ranges from 720 to 1,200 r.p.m. This unit is electrically started from a storage battery. Bosch injection is used with a special form of combustion chamber. The larger engine, Type EN, has 8x10½-in. cylinders and is rated 25 to 40 hp. per cyl., depending upon speed. It is built in 3, 4, 6 and 8-cyl. combinations, running from 500 to 700 r.p.m. The injection system is a modification of the "common rail" type combined with the new atmospheric relief principle described in *Power* some time ago. Both units are completely enclosed, with automatic pressure lubrication.

Fairbanks, Morse & Co. showed five engines, including a 6-cyl., 8¾x10½-in., 2-cycle solid-injection unit with air starting. The exhibit also included a new line of light-weight comparatively high-speed, 4-cycle diesels in a complete range of sizes, beginning at 8 hp. The smaller units are started by crank and those above 3 cyl. by electric starters.

Hercules Motor Corp. showed a 4-cyl., solid-injection, 5x6-in. unit, operating up to 2,000 r.p.m. The 6-cyl. model is rated at 100 hp. at 1,000 r.p.m., 177 hp. at 1,800 and 188 at 2,000.

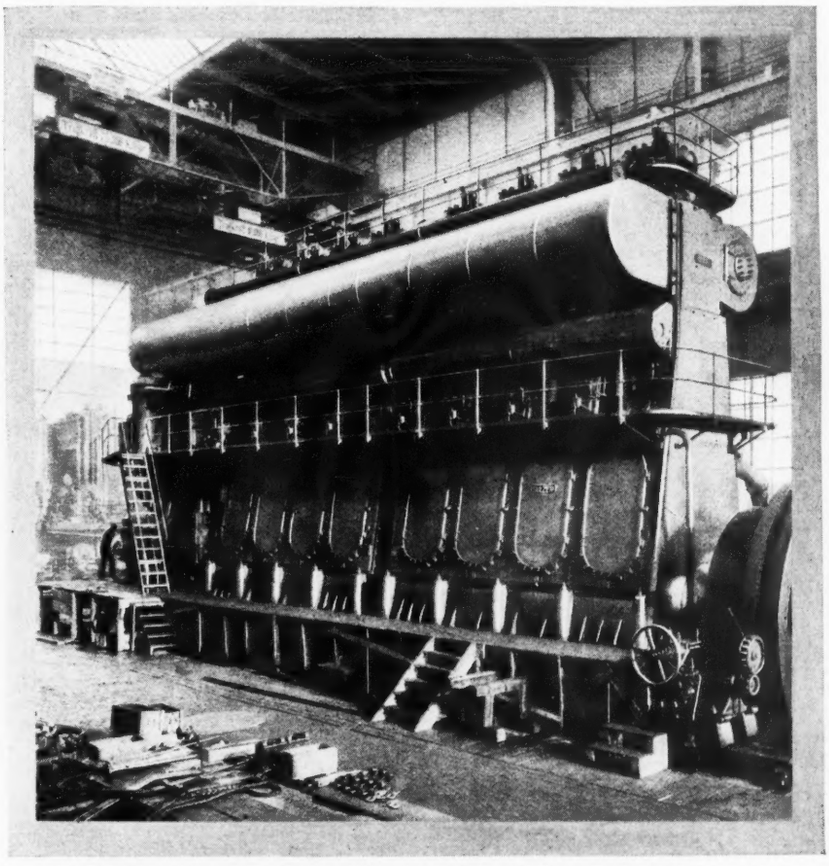
Hill Diesel Engine Co. showed a new high-speed full diesel weighing only 12 lb. per hp. It is a V-8 with bore and stroke of 5x7 in. and developing 200 hp. at 1,650 r.p.m. The cylinders and crankcase are cast enbloc.

Murray & Tregurtha Inc., showed a 6-cyl., 6½x8 in., rated at 110 hp. 700 r.p.m., 140 hp. at 1,100, and weighing 3,700 lb. Electric starter is used. This unit is also built in a 4-cyl. design. The engines are started on fuel oil by means of a special electric heating unit.

Red Wing Motor Co., old-line manufacturer of high-grade gasoline engines, has introduced a new line of oil engines of 4-cyl., 4-cycle design in three sizes, 30 hp., 50 hp. and 70 hp. with maximum speeds of 1,400 r.p.m., 1,200 and 900, resepectively. Bore and stroke of the small unit is 3¾x4¾; intermediate 4½x5½, and the large 6x6½. A series of 6-cyl. fuel oil engines of similar design from 120 to 180 hp. are also under development.

Winton Engine Corp. showed the new eight-in-line, 2-cycle solid-injection, 600-hp. engine, direct-connected to a generator which is the type to drive the Burlington railroad's new high-speed passenger train.

All but the last of these engines are marine types. Most of them can be supplied, however, with generator direct connected, so they can be adapted for stationary and standby service.



13,700 hp. more for the world's largest diesel plant—the double-acting 2-cycle Sulzer diesel that will step up the capacity of the Shanghai, China, municipal plant to 51,200 hp. It is shown on the floor of the erection shop at Winterthur

NEW BULLETINS

Liquid-Level Gages—The Foxboro Co., Foxboro, Mass., 20-page Bulletin No. 187, "Liquid Level Gauges," includes complete description of industrial and commercial uses and mechanical construction of Foxboro units.

Capacitors—The Ideal Electric & Manufacturing Co., Mansfield, Ohio. Bulletin 710, "Ideal Capacitors for Power Factor Correction," gives 16 pages of data on units recently described in Power.

Air Filters—Staynew Filter Corp., Rochester, N. Y. Six-page folder on "Protectovent" air filters and noise eliminators for window-type ventilating units.

Asphalt Paint—American Asphalt Paint Co., 43 E. Ohio St., Chicago. 16-page souvenir book, "Color and Protection," shows 35 authentic water color illustrations of buildings at Chicago World's Fair.

Iron Pipe—Republic Steel Corp., Youngstown, Ohio, 64-page Form ADV. 220-B, "Toncan Iron Pipe for Permanence," in two parts: Part I includes technical data and test results, Part II includes installations and a variety of service records.

Centrifugal Pumps—Worthington Pump & Machinery Corp., Harrison, N. J. 4-page bulletin on Monobloc centrifugal pumps, 2-stage, types G, GA, GB.

Diesel Engines—Busch-Sulzer Bros. Diesel Engine Co., St. Louis, Mo. Two new bulletins: 16-page "Depression Development—6 New Busch-Sulzer Diesels" describing world's largest locomotive diesel and world's largest trunk-piston diesel, the latter in 2-cycle sizes from 1,050 to 10,000 hp., and in 4-cycle sizes from 225 to 1,000 hp. 36-page "Larger Railroad Diesels" describes units from 1,600 to 3,500 hp., all 2-cycle, single-acting, "V" type, solid-injection units weighing under 25 lb. per hp.

Cement Gun — Cement Gun Co., Inc., Allentown, Pa. 50-page Bulletin 200 describes the Cement Gun and "Gunite," its sand-cement product.

Thermit Welding—Metal & Thermit Corp., 120 Broadway, New York, N. Y. 8-page "Thermit Welding — Industry's Master Maintenance Tool," shows application in repair of machine parts, castings, crankshafts; gives repair and cost data.

Electrically Welded Iron Pipe—Republic Steel Corp., Youngstown, Ohio. 24-page Form Adv. 222-B, "The Technical Story of Toncan Iron Pipe," contains facts, figures and technical data on manufacture, applications and performance.

Rawhide-Faced Hammer—Greene, Tweed & Co., 109 Duane St., New York, N. Y. 8-page folder on "Basa" Hammer, which has rawhide face and delivers clean blow without injury to surface struck.

Anti-Friction Bearings—Fafnir Bearing Co., New Britain, Conn. 8-page booklet, "An Outline of History for Anti-Friction Bearings." Reprinted from "The Dragon," house organ of Fafnir Bearing Co.

Gage Glasses — Corning Glass Works, Corning, N. Y. 8-page circular on Pyrex High-Pressure and Red Line Gage Glasses. Includes technical data.

Flat-Belt Motor-Drive Base — Rockwood Manufacturing Co., Indianapolis, Ind. New series of bulletins on types of Rockwood drive. These include 6-page on Ceiling Drive Base, 12-page on Standard Drive Base, 6-page on Bases for Small Motors, 6-page on Portable Power Trucks (also being used for industrial plants where spare portable motor outfit is needed), 6-page on Vertical Drive Base. Same bulletins also available from Chicago Belting Co., Chicago, Ill.

Laboratory Centrifugal Separator — Sharples Specialty Co., 23rd & Westmoreland Sts., Philadelphia, Pa. Four-page bulletin describes new Sharples Laboratory Super-Centrifuge, showing both turbine and motor drive heads, first operating at 50,000 r.p.m.

Heating Elements—General Electric Co., Schenectady, N. Y. GED-571, "Spots of Heat for Industrial Plants," describes strip, spot and dip heaters.

Ammonia Compressors—Carbondale Machine Co., Carbondale, Pa. Bulletin 1133, "Carbondale Combined Units with Duplex Vertical Ammonia Compressors," includes tables of pipe connections, over-all dimensions, typical installations.

Quarter-Turn Valves—Homestead Valve Mfg. Co., Coraopolis, Pa. 24-page pocket catalog on quarter-turn valves. Also includes two-, three-, and four-way valves hooked up for various fluids, gases and vapors.

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ark., Conway—City plans light plant. $45,000 approved by Washington. $31,500 loan and $13,500 grant. E. V. Leverett, Conway, archt.

Ariz., Yuma—City plans election $300,000, for power and light plant. Will ask P.W.A. loan.

Bakersfield, Calif.—F. W. Nighbert, city mgr., will prepare estimates of cost for submission to city council for Diesel-driven generating plant in connection with street lighting and for other municipal purposes.

Calif., Healdsburg—Geysers Development Co., 417 South Hill St., Los Angeles, plans application for P.W.A. loan to finance construction of steam turbine, electric generating plant at the "Geysers." $250,000. C. L. Straub, Mosswood Rd., Berkeley, engr.

Ill., Chicago—Sanitary Dist. of Chicago, 910 South Michigan Ave., Chicago, plans power house, incl. two 8500 k.w. units at Lockport. $800,000. P. Harrington, 910 South Michigan Ave., Chicago, engr.

Ill., Peru—City plans improving power plant, incl. changing coal handling machinery from D.C. to A.C. current, steam flow meters. $10,000. K. R. Drown, Rockfort, engr.

Ind., Cicero—City had surveys made for electric light plant. $32,000. T. N. Wynne, 211 East North St., Indianapolis, engr. Applied for loan under P.W.A.

Ind., Tipton—City, I. Finley, clk., bids about Mar. 1, electric light plant. $169,398. P.W.A. loan granted. Bevington & Williams, Inc., Pythian Bldg., Indianapolis, engrs.

Ia., Iowa City—Municipality plans electric power plant. $50,000 or more. W. E. Schwab, Iowa City, engr.

Ia., Manning—City plans power plant. $115,000. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, engrs. Application for P.W.A. loan and grant.

Ia., Villisca—City plans either Diesel engine or steam power plant. $115,000. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs. Applied for loan and grant under P.W.A.

Ky., Middlesborough — City plans municipal light and power plant and distribution system. $325,000 loan and grant obtained from P.W.A. R. Husselman, Hippodrome Bldg., Cleveland, O., engr. May decide to build distribution system only and obtain power from Tennessee Valley Authority.

La., Harrisonburg—City filed application for P.W.A. loan to finance construction water, light and ice plant. $90,000. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

La., Robeline — City made application for $40,000 P.W.A. loan to finance construction waterworks and light plant. F. P. Joseph, Glenmora, engr.

Me., North Eastport—Dexter Cooper Corp., Inc., D. P. Cooper, pres. and chf. engr., Eastport, made application to P.W.A. for loan to finance construction Tidewater hydro-electric power development, in Bay of Fundy, incl. main plant, power storage plant, transmission plants, dams, locks, relocate railroad and highway. $60,000,000. Private plans.

Minn., Morris—Voted $188,000 bonds light and power plant. Burlinghame & Hitchcock, 526 Sexton Bldg., Minneapolis, engrs.

Minn., St. Cloud—City plans municipal power plant and distribution system. $1,294,000. Applied for loan under P.W.A. Burns & McDonnel, 107 Linwood Blvd., Kansas City, engrs.

Minn., St. Paul—City election Mar. 6, $10,230,000, for municipal electric light and power plant. G. M. Shepard, city engr.

Minn., Winthrop—City, C. A. Schilling, clk., plans municipal power plant. $60,000 or more. R. W. Richardson, 410 New York Bldg., St. Paul, engr.

Mo., Anderson—City plans dam and hydro-electric plant. $60,000. Applied for loan and grant under P.W.A. W. Christerson, Anderson, engr.

Mo., Farmington — City plans power plant. $120,000. A. L. Mulergran Co., 220 Fairfax Bldg., Kansas City, engrs. Applied for loan and grant under P.W.A.

Mo., Independence—City plans light plant improvements, incl. 3,000 kw. turbine and pipe work. $175,000. Black & Veatch, 700 Mutual Bldg., Kansas City, engrs. Applied for loan and grant under P.W.A.

Mo., Pattenburg—City, D. G. Graham, mayor, plans municipal light and power plant, incl. distribution system. $67,420. Applied for $17,420 grant and $50,000 loan under P.W.A. E. T. Archer & Co., 609 New England Bldg., Kansas City, engrs.

Mo., Rich Fountain—Gasconade River Power Co., 605 R. A. Long Bldg., Kansas City, plans dam and power development. $10,000,000. Will file application with Federal Power Comn. Private plans.

Mont., Crosby—Voted bonds to be used as security for $60,000 P.W.A. loan to construct municipal electric light and power plant.

Mont., Forsyth—Municipality plans light and power plant. $135,000. Applied for loan under P.W.A.

Neb., Gering—City plans light plant. $65,000. Engineer not appointed. Applied for loan and grant under P.W.A.

Neb., Hastings — General Nebraska Public Power & Irrigation Dist. plans hydro-electric plant and irrigation system. Est. cost Unit 1 $29,024,267, Unit 2 $7,033,424. Applied for loan under P.W.A. D. Kingsley, pres. R. C. Mickey, engr.

N. J., Woodbury—Mayor and City Council plans electrifying municipal water pumping station. J. Morgan, chn. $50,000. Will ask loan and grant under P.W.A.

N. Y., Auburn—City plans generating plant and street lighting system. $310,000. Applied for loan and grant under P.W.A. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

N. Y., Rockville Center—Village plans municipal light plant. $260,000. Applied for loan under P.W.A.

N. C., Gibsonville—Town, J. G. Steele, mayor, plans sewage treatment plant, well and pumping equipment. $22,000. P.W.A. loan granted. Carolina Eng. Co., Johnston Bldg., Charlotte, engrs.

N. D., Jamestown—City plans municipal electric light and power plant. $600,000. Applied for loan under P.W.A. G. R. Horton, city engr. Burlinghame & Hitchcock, 526 Sexton Bldg., Minneapolis, Minn., making surveys.

O., Cleveland—W. J. Rogers, dir. P. Utilities, City Hall, completing plans blower and power building for Easterly Sewage Treatment Plant, East 140th St., and Lake Shore Blvd. $300,000, P.W.A. project. G. B. Gascoigne, 1140 Leader Bldg., engr.

Okla., Taft—City plans municipal light plant. $139,000. Applied for loan under P.W.A. J. O. Jones, city engr.

Pa., East Pittsburgh—East Pittsburgh Boro plans application for P.W.A. loan to finance construction of electric power, generating and distributing system. $353,000.

Tex., Bartlett—City, c/o Mayor, voted $90,000 for construction municipal light plant.

Tex., Marlin—City, c/o C. R. Glass, filed application for P.W.A. loan to finance construction electric light and power system. $175,000. L. Goodrich, Marlin, engr.

Tex., Lubbock—City, c/o Mayor, filed application for P.W.A. loan to finance construction electric and power plant improvement. $10,000.

Tex., Port Lavaca — City, F. M. Dudgeon, mayor, plans waterworks improvements, incl. new wells, pumping equipment, mains, etc. $54,000 loan and grant approved by P.W.A. J. C. McVea, M. & M. Bldg., Houston, engr.

Va., Covington—City plans municipal power plant. Applied for $402,365 grant under P.W.A. Wiley & Wilson, Lynchburg, consult. engrs.

Va., Danville—City plans 3 small dams, conduit under mountain, power house, transmission lines near Pinnacles of Dan. $3,000,000. Schofield Engr. Co., Commercial Trust Bldg., Phila., Pa., engrs.

Va., Galax—Municipality plans hydro-electric plant on New River, incl. transmission lines, auxiliary diesel engine power plant and substation. $265,000. Applied for loan under P.W.A.

Wis., Eau Claire—Gillette Rubber Co. plans power plant addition. $45,000.

Ont., Minden—Town of Orillia Water, Light & Power Comn., plans construction hydro-electric power plant on Gull River, near here, developing 5,000-8,000 hp., 110 ft. head concrete dam, power house, water turbines, electric generators, transformers, switchboard equipment, etc. $400,000. Private plans.

Sask., Riverhurst—Group of Moose Jaw men plans completed for hydro-development on South Saskatchewan River, north of here, and forwarded to Saskatchewan Provincial Govt. and Federal Dpt. P. Wks. for permission to proceed with work. Proposed development of water power includes constructing 5,800 ft. dam, 200 ft. high, 100,000 hp. electric power generating plant, 1,000,000 acre irrigation scheme. Facilities to provide 10 m.g. water for Regina and Moose Jaw is required. $15,000,000. W. R. Bennett, Moose Jaw, chn. A. W. E. Fawks, Moose Jaw, engr.

South Africa, Pretoria—Bids Mar. 2, by M. G. Nicholson, town clk., turbo-alternator with condensing plant and auxiliaries, also 2 stoker feed boilers equipped with auxiliaries and one 50 ton overhead electrically operated crane. Marz & McLellan, 22 Victoria St., London, England, engrs.